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Fast Concreting on Brooklyn-Brighton Viaduct, Cleveland

Rapid progress marks the construction of a long concrete arch viaduct which Cuyahoga County is building in the southwestern part of Cleveland, Ohio. The viaduct is 1726 ft. long, and includes six 128-ft. arches besides many shorter ones. An existing steel viaduct carrying a heavy traffic complicates the work, as it interferes with the new structure and requires it to be built in longitudinal halves to maintain traffic. In less than 11 months' time, including the winter shutdown, the Bates & Rogers Construction Co., Chicago, has completed the west half.

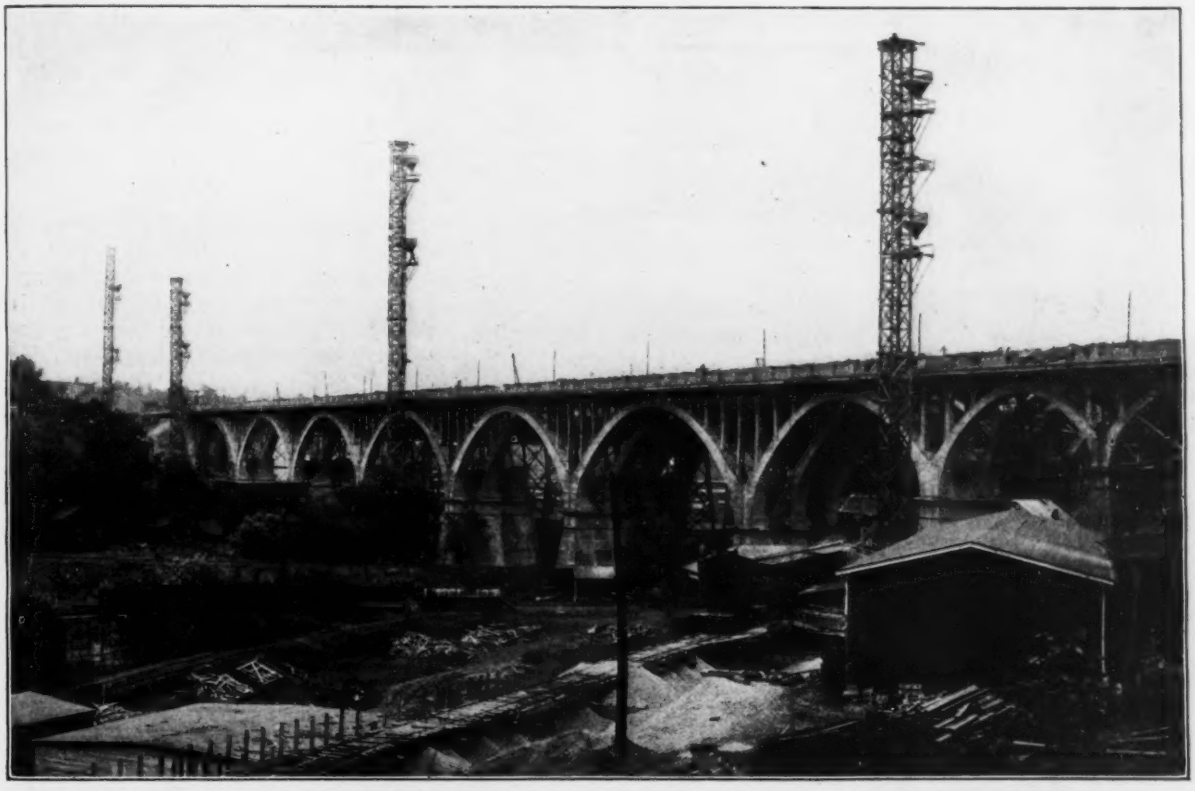


FIG. 1. BROOKLYN-BRIGHTON VIADUCT, CLEVELAND, AT COMPLETION OF WEST HALF

Construction began in September, 1914, shortly after the contract was signed. By the end of the season one abutment and a few piers were partly built, while most of the foundation pits had not even been started. The view Fig. 1 shows how the viaduct appeared July 28, 1915, as seen from Brookside Park road, to the west. The structure looks practically complete, but the entire east half is yet to be built (see view Fig. 2). The contractors expect to finish by the end of the present season.

The design, shown by Fig. 3, is unusually successful as regards esthetic effect. This lies partly in the general proportioning, partly in the arch-rib curvature (adjusted to the dead-load pressure line, with short end curves joining the piers tangentially) and partly in the omission of heavy pilasters over the piers in favor of a column system throughout, with columns intentionally so spaced that they do not come over the piers.

The six largest arches have a span of 128 ft. clear (139 ft. c. to c. piers) and a rise of 43 ft. clear. A prominent characteristic of the viaduct is the use of unsymmetrical arches—with one skewback at higher elevation than the other—at the side slopes of the valley. This permits of starting both arches on a pier from the same spring elevation and at the same time keeping the pier tops about the same distance above ground at all piers.

All the arches, in fact, are unsymmetrical, though most of them are only slightly so. Throughout the middle part of the viaduct the plane of the spring lines is parallel

FIG. 2. EAST FACE (MIDDLE) OF BROOKLYN-BRIGHTON VIADUCT

View taken same day as Fig. 1

to the roadway slope (0.4% up toward the south). The arch curves themselves have vertical axes, except for the short terminal curves near the spring line, whose radii are adjusted to give the proper terminal elevation.[1]

The floor-panel length was made uniform (11 ft. 7 in.) with a view to duplication of floor forms as well as to securing good appearance. Span lengths were adjusted to be multiples of this length.

The extrados faces of the ribs in adjoining spans are connected by a curve. In the transverse plane the feet of the four ribs on each pier are joined by heavy filleting in the form of an elliptical invert arch that has value for both appearance and rigidity of the structure.

Expansion joints in the floor, located over every pier, are at mid-length of a stringer. The two half-stringers act as cantilevers and for this purpose are made deeper than the regular stringer (see cross-section in Fig. 4). The joint is perfectly open and has no load to transmit, to interfere with free expansion as in the case of a stringer-end sliding on a seat.

The floor, a normal arrangement of slab, stringers and floor-beams, is depressed 8 in. on the width of the double-track street-car line to make space for the track (4-in. steel I-shaped ties, 7-in. rails, 1-in. depth of ballast cushion under ties). The roadway is divided between tracks by a low concrete curb-wall, inclosing and fendering the 10-in. sockets of the trolley-poles.

The pavement is to be of 4-in. granite block on half the width, and "Durax" granite block on the other half, both laid on sand cushion on asphalted burlap waterproofing.

Interference with the Old Viaduct

West 25th St. is carried south across Big Creek valley by an old steel viaduct. The site of the new viaduct, on a slightly revised alignment, is west of the old structure, but overlaps it on most of the length, as the plan in Fig. 3 shows. However, it was possible to build the west half of the concrete viaduct complete without disturbing the old viaduct except to cut a narrow strip off its west side for a length of some 200 ft. at the north end. The

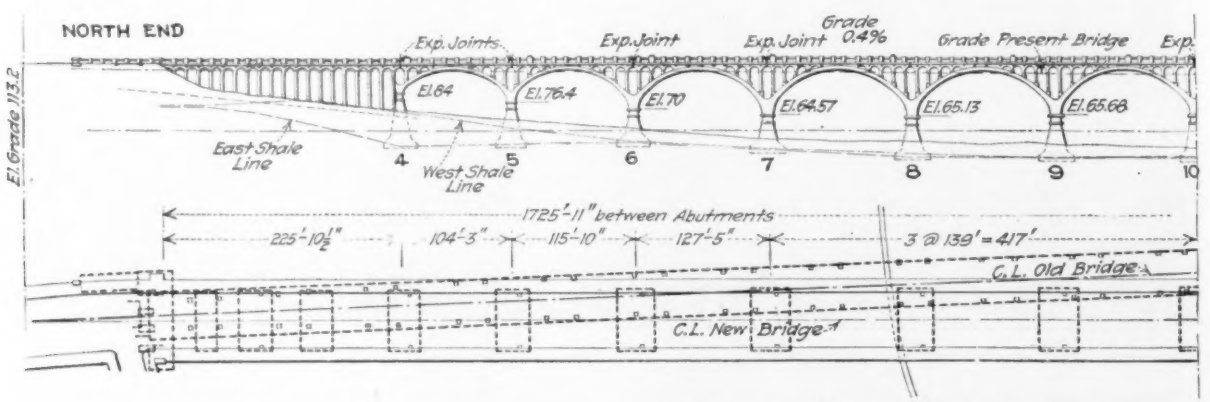


FIG. 3. BROOKLYN-BRIGHTON VIADUCT ACROSS

There are some other features of the design that merit study. The four ribs have no transverse connection, but are independent for the entire span length; only the floor and columns connect them. A low cross-wall 18 in. thick, between ribs just over the piers, provides some lateral stiffness. There is also a pair of diagonals between the inner posts nearest each pier.

[1]The terminal curves are shorter than they appear in the elevation of one arch in Fig. 4, as the drawing has the main curves somewhat off scale.

completed half could then carry the traffic, whereupon the old viaduct could be torn down and the east half of the new structure built. This procedure was followed.

The old viaduct floor-beams in the northerly interfering section were burned off by oxygen flame, and the cut ends of the remaining width supported on temporary timber bents. Cars operate over a single track in this narrowed portion, turning out to double track beyond.

The new structure was started at the south end and built northward in regular progression. Floor construction near

the south end, arch-rib concreting north of here, pier concreting beyond, and footing work and excavation at the north end went on simultaneously.

One of the conditions that facilitated this arrangement was the uniform and excellent character of the foundation soil. Hard shale in massive deposit lies near the surface, outcropping even high up on the bluffs. Therefore the construction of the footings was simple work, free from risk of delay or necessity for change of method. The excavation was done with the use of steam tripod drills except at the pier just south of the creek, where the cutting was so deep that 20-ft. holes were put down by hand drills, as the machine drills tended to stick. The muck was handled by a stiffleg derrick set up alongside the pit, into carts which hauled it away to approach fills.

The supply route of materials determined the type and placing of plant and thereby largely dictated the construction methods. Two railways pass through the valley, not far from the third-points of the length of the viaduct; the stone, sand, cement and other materials could thus be brought in direct and unloaded immediately alongside the viaduct at two different points. This meant storing and mixing in the valley and hoisting the mixed concrete.

The contractor chose tower hoisting and spouting in preference to handling by cableways. A layout showed that four towers could command the whole length—two located at the points of storage and mixing and two so located as to receive concrete from the spouts of the other two and rehoist it to be chuted again. Fig. 5 shows diagrammatically the location of the towers relative to the viaduct length; transversely they were set to clear the west face of the deck about 5 ft. The tower locations and heights were laid out for a chute angle of 2¾ to 1.

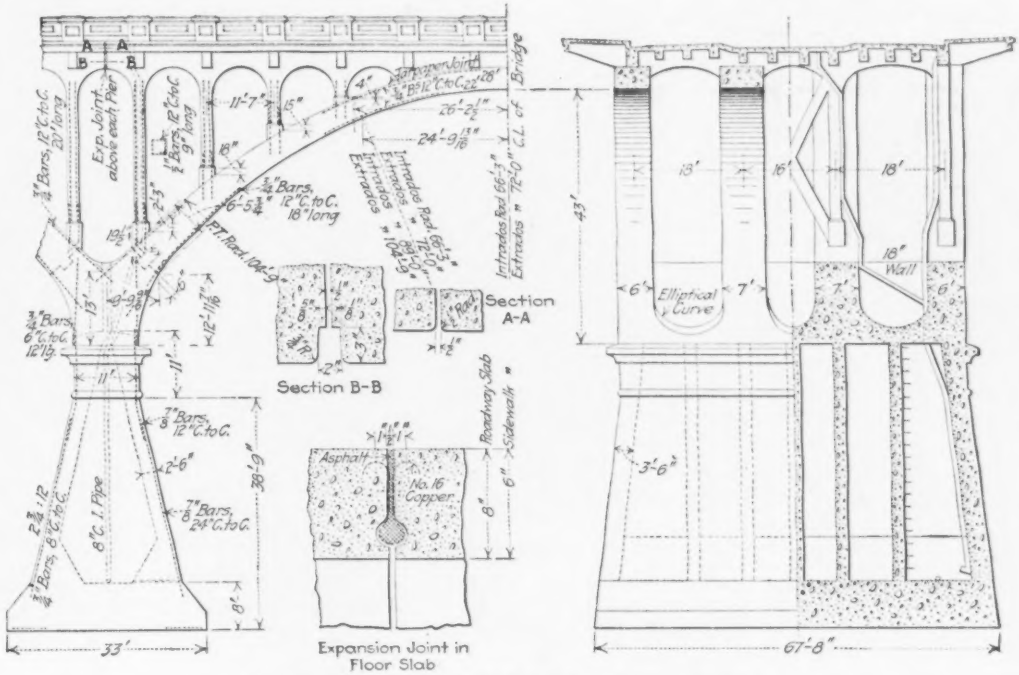
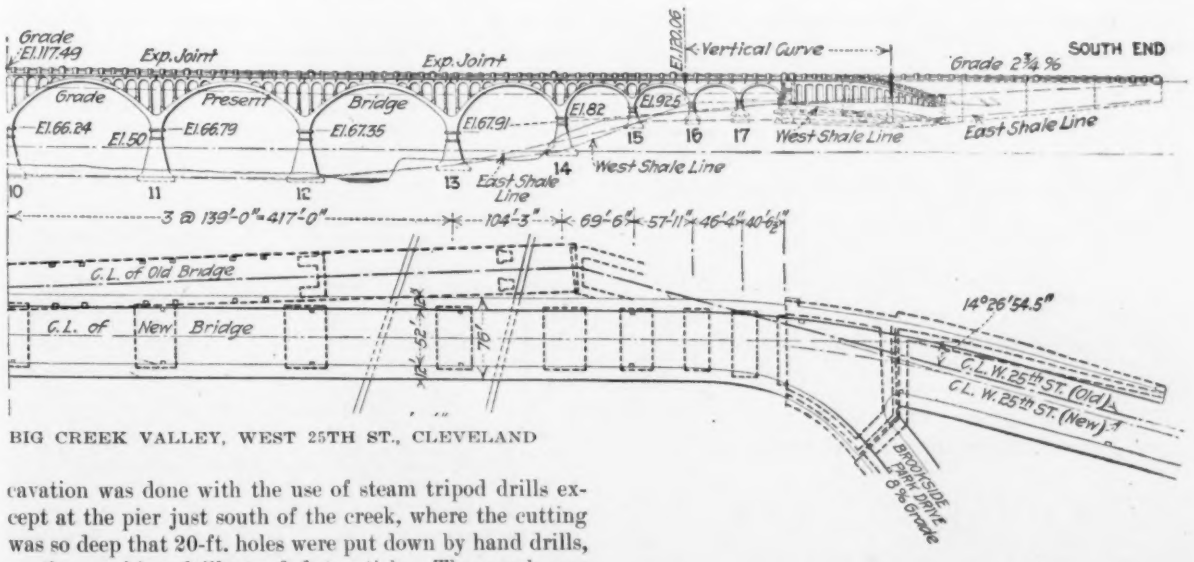


FIG. 4. TYPICAL DETAILS OF ARCH CONSTRUCTION



BIG CREEK VALLEY, WEST 25TH ST., CLEVELAND

As the piers were designed to take unbalanced dead-load thrust, the centering and concreting could go on in any desired order.

Steel centers of the three-hinged arch type were adopted, with a view to using the centers of the large 128-ft. spans also for the shorter spans by taking off sections. The tie-rods of the centers were used only in setting and in slacking; when in place the centering arch was supported vertically by blocking on the skewback belt-course and horizontally by wedges against the arch stubs that had been centered with the piers. The sketch Fig. 6 shows how the centers for a pair of ribs are braced together and

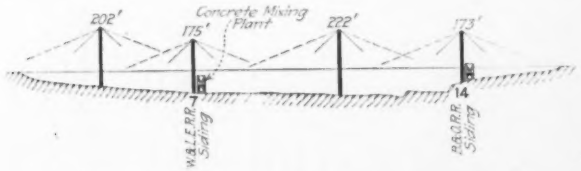


FIG. 5. LOCATION OF CHUTING TOWERS

how they are sectionalized for ease of erection and handling. The American Bridge Co. built the centers at its Ambridge plant.

Centers were provided enough for six spans (two ribs each, the ribs being concreted in pairs). For the three small spans at the south end, trussed wooden centers were built. These were intended to be used over once; the pair of centers in each span was left in place—these spans having been concreted last April—and will be rolled over next month to do service for the construction of the two easterly ribs of the same span.

Handling the Centers

The centers were erected by two 80-ft. gin-poles, each of which lifted a half-arch of one truss (see Fig. 6; the two sections of the half-arch were bolted together on the

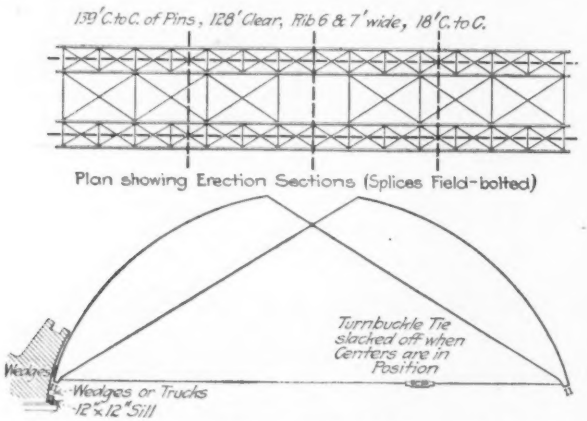

139' C. to C. of Pins, 128' Clear, Rib 6 & 7' wide, 18' C. to C.
Plan showing Erection Sections (Splices Field-bolted)
Turnbuckle Tie slacked off when Centers are in Position
Wedges
Wedges or Trucks
12"x12" Sill

FIG. 6. SECTIONALIZING AND BRACING OF ARCH CENTERS

ground) and set it to join with the other at the crown pin. The tie-rod being put in and screwed up and the arch guyed, its mate was similarly hoisted and set and the pair braced by placing the lateral members. Then the parallel pair of centering arches was set and the bracing between the pair put in, completing the centers for a pair of ribs.

In taking down the centers, falls hung from the finished concrete arch were used to lower the half-trusses to the ground. Here they were unbolted, lifted on wagons and trucked to the next arch that was to be centered.

Arch and Pier Forms

The forms for piers and arches were made to be used only once; the contractor did not consider it economical to build sectional forms made to be used repeatedly.

The arch forms are shown typically by the sketch Fig. 8. Horizontal side sheathing was scribed to the bottom lag-

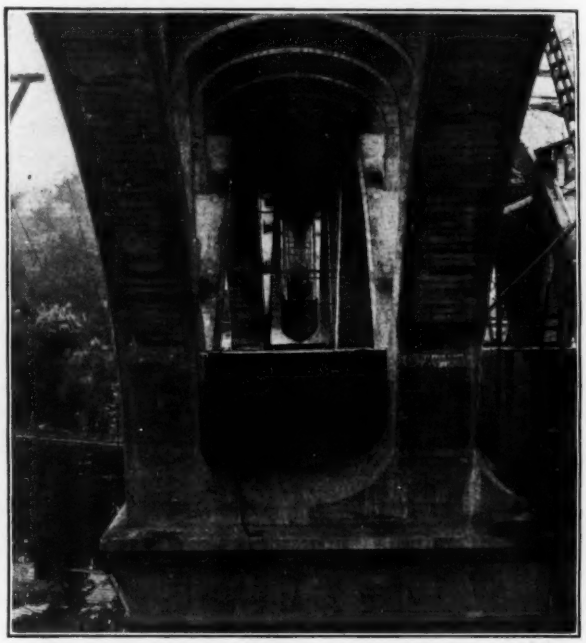


FIG. 7. VIEW UNDER MIDDLE OF WEST HALF, BROOKLYN-BRIGHTON VIADUCT

The appearance of the staining is due to heavy rain just before the picture was taken

ging and its upper line left irregular. Vertical wales with tie-rods through the arch held the sheathing. Top lagging was nailed to the under side of a 2x2-in. curve batten nailed on the inside of the sheathing; 1-in. bevel fillets were tacked in the four corners of the form.

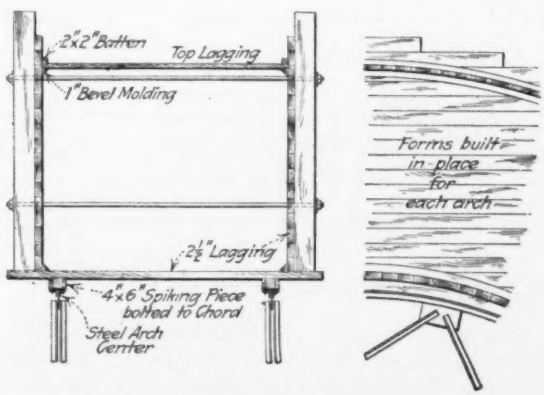


FIG. 8. ARCH-RIB FORMS

These forms proved rapid and simple in construction, and did not call for any hoisting appliances.

In designing both arch and floor forms, special care was taken to limit the deflection; ⅛ in. was considered the maximum permissible deflection. The two chief limits

in design were deflection in bending and cross-grain crushing under washers and wales.

Alternate Concreting of the Ribs

The steel centers were capable of carrying one panel excess load on either side. Therefore the concrete was placed in a sequence that kept the load balanced within one panel-load.

Fig. 10 sketches the procedure. Concrete from the chute was allowed to run down the outside of the top lagging on one side of the middle, to a hole cut a few feet above the spring. When the rib had filled up to the level of this hole the hole was closed and the spout was swung to discharge on the other side of the middle.

The concrete running down on that side went through a hole cut at an elevation several feet higher than the other. After this another lift on the first side was concreted, and so on alternately until the central section was reached. Top lagging was omitted for a length of 12 ft. at the middle, and the chute discharged direct into this open space, filling the middle 50-ft. length of ring.

The arch-rib top lagging was removed the day after concreting. The sides were taken down the second day. The centers were struck in 21 days; but in two spans the time was only 15 days, without injurious effect.

Column and Floor Forms

The column forms, like all the others, were unlined, that is, had plain wood faces. Special care was taken in building them to get a smooth face. Two coats of paraffin form oil were put on.

The floor forms and column forms were always built up together, but the columns were poured two days before the rest. The day after, the column forms were stripped—the floor-beam forms being supported independently on transverse 12x14-in. by 38-ft. outlooker timbers—and the columns rubbed.

The floor forms were built sectional and this in such a way as to make the path of transmission of load in the forms the same as in the finished structure. The stringer forms rested on ledges of the floor-beam forms, and the slab forms on the stringer forms. All parts were designed with 1-in. clearance horizontally, and the clearance space was covered with a 2-in. strip of tin nailed over (see view, Fig. 9).

Floor forms were built for 600 ft. length of floor, and floor concreting progressed without much interruption. Because of the sectional construction the panels of form removed from the rear were simply carried to the front of the work and built up.

FIG. 9. A SPAN OF FLOOR FORMS, BROOKLYN-BRIGHTON VIADUCT

The heavy items of reinforcing steel were handled on the forms by small gantries (large wooden horses) from which a chain block was hung. The floor-beam reinforcement was the principal item, weighing about 5 tons. This was assembled on blocking just above the floor-beam, and when all wired was lowered into the form.

Floor concreting went on at the rate usually of about 70 ft. (half of a large span, 139 ft. c. to c. piers) per day.

FIG. 10. METHOD OF CONCRETING ARCH RIBS

Thus the forms amounted to about 10 days of floor work—about the normal time of stripping. In one instance the whole 139-ft. length was concreted in a day of 8 hr., taking 350 cu.yd.

Rubbing Concrete Surfaces

All surfaces that would be seen in an elevation of the bridge were rubbed by the use of a wooden float and water. This work was done as soon after the concrete was poured as was possible to strip forms. On all walls where

no stresses were being carried by concrete the forms were stripped within 24 hr. and the concrete rubbed. Thus on this basis all surfaces shown as an elevation of the bridge were rubbed within 24 hr. after the concrete was poured. In addition to this all of the piers were rubbed to the springing line, as this portion of the work is very easily seen from the ground. None of the surfaces on the underside of the arches were rubbed, nor those underneath the floor system.

Rapid Concreting Record

The usual time required for pouring a pair of arch ribs (the westerly two ribs of one span) was 7 to 8 hr. This involved 320 cu.yd. of concrete in the case of the large (128-ft.) arches.

Much faster concreting was done in some of the pier work. In one pier 539 cu.yd. was placed in 9 hr.—a depth of 29 ft. of concrete. The South plant did this work, with a 25-ft. Smith tipping mixer.

In the case of this pier it was found that the concrete was still quite fluid 12 ft. down, and pasty to stiff 18 ft. down, a depth corresponding to about 5 hr. run. But the concrete materials were heated, which should accelerate the set.

There was little trouble from clogging of the chutes. The North plant in fact has plugged only once during the season. The concrete was of several mixtures and used three sizes of stone—1-in. for the superstructure, 1½-in. for retaining-walls, and 2-in. for piers and footings. The larger sizes gave a little more trouble in the chutes than the smaller.

Progress of Construction

The work accomplished in 1914 was: West half of south abutment, piers 16 and 17, and half the height of piers 12 and 14 concreted, and some further excavation made and two footings poured.

In February, 1915, the North concreting plant was put up. Early warm weather allowed concreting to begin Mar. 8, on pier work. The first arch was poured Apr. 13 and the last one July 13—just three months' time—including all four ribs in three of the spans (pier 12 to 15). Floor concreting began May 9 and was finished July 21, a total of 1726 ft. in length, all of it on only the west half.

Floor work is now in progress in the three spans whose cast ribs are in place, and some footing excavation is being done around the piers of the old viaduct. By the middle of August it is expected that the new viaduct will be carrying traffic and the demolition of the old one begun. As already stated, the contractors expect to finish the entire work by the end of the year. The paving is a separate contract.

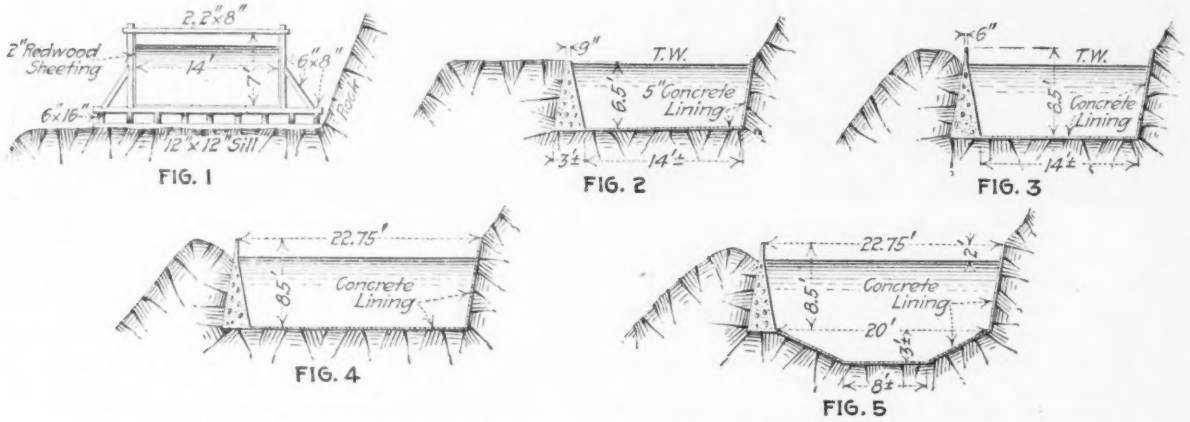
Work is now one week ahead of the schedule made out last winter for the season's work. This gain was made in spite of a net loss of a week from delay of materials, etc.

The foregoing is based on information given by C. S. Smith, superintendent for Bates & Rogers Construction Co. on the work, with respect to the construction, and by A. W. Zesiger, Bridge Engineer of the county, as to the design. Mr. Zesiger is responsible for the design, under W. A. Stinchcomb, County Engineer. W. H. Baker is resident engineer for the county.

Enlarging an Irrigation Canal

By Kenneth A. Heron*

The main canal of the Modesto Irrigation District, California, was originally built to carry 535 sec-ft., but it was found to have a capacity of less than 300 sec.-ft., when first used in 1904. Since that time it has been enlarged several times, until at present it is being constructed to a final capacity of 2000 sec.-ft. The canal



FIGS. 1 TO 5. THE DEVELOPMENT OF AN IRRIGATION CANAL

Fig. 1—First stage: A timber flume. Fig. 2—Flume replaced by concrete-lined canal. Fig. 3—Lining raised to increase capacity. Fig. 4—Canal widened from 14 to 20 ft. Fig. 5—Canal deepened 3 ft. at center

diverts water from the Tuolumne River at the La Grange Dam and for the first mile or so is located on a steep hillside about 100 ft. above the river bed. This first mile was the most difficult to locate and construct in the first place, and since construction it has presented the great obstacles to be overcome when enlargement was considered. Originally, the first 4000 ft. consisted of a timber flume laid on a shelf excavated in the hillside (Fig. 1). The canal capacity at that time is said to have been about 250 sec.-ft.

During a long period of litigation and financial trouble in the district, when the money could not be obtained to complete the irrigation works, this flume stood with very little water in it, and decay was rapid. When the time to replace it arrived, however, conditions in the district were better and the timber structure was taken out entirely and a concrete-lined canal section, as shown in Fig. 2, was substituted. This section had a varying width of

*Irrigation Engineer, Modesto, Calif.

14 or 15 ft., a lining about 6 in. thick and a concrete wall on the lower side having a gravity section where there was no bank. This was backfilled with rock and earth, and the whole canal was located farther in the hillside than was the first structure. The capacity of this section was about 400 sec.-ft.

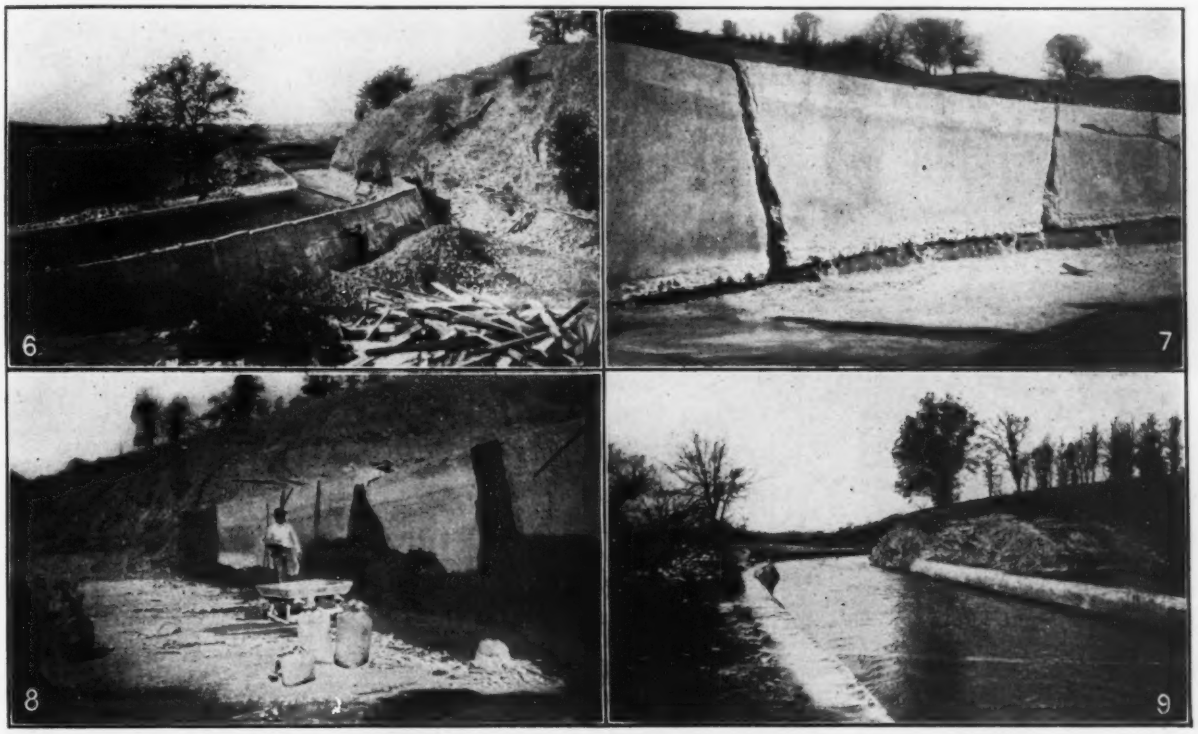
As the district developed and more land was brought under cultivation it was necessary to "crowd" the canal as much as possible, until it became customary to allow very little freeboard. The danger of the water topping the wall and washing out the backing and the necessity of obtaining more water led the district authorities to raise the concrete walls and lining about 2 ft. (Fig. 3). When this work was completed the canal capacity was increased about 100 sec.-ft. The rapid development of the district and the bringing of more lands under irrigation again required that the canal capacity be increased and in 1908 steps were taken to enlarge the size of the canal once more. Owing to certain fixed conditions at the headworks the hydraulic grade could not be raised without great expense, and it was decided to widen it to 20 ft. (Fig. 4). To do this it became necessary, in those portions of the canal which were concrete-lined, to tear out one wall, make the necessary excavation and replace it in the proper position.

This was done in places by excavating behind the wall to be moved and then carefully dynamiting it to break it into pieces of such sizes as could be easily pushed out on blocking with jacks. When moved to the proper position, the wall sections were carefully adjusted to fit as closely as possible and all cracks were plastered with cement mortar. New concrete was placed under the sections for foundations. The backfill was then placed behind the wall. Because of the care with which the work was done no more leakage developed than if the whole wall had been molded in place, and in appearance it is just as substantial. The capacity of the new canal section was approximately 800 sec.-ft.

Since this work was done the development of the district has been very rapid, and the recent construction of a reservoir which is supplied by this canal, together with new lands to be brought under cultivation, led the district authorities a year ago to call for plans and estimates for a canal of 2000 sec.-ft. capacity. At the time I was called upon to make surveys for this enlargement, two plans were under consideration. One called for the removal of 80,000 cu.yd. of rock and the placing of 7500 cu.yd. of concrete, at a total cost of $250,000. This plan necessitated widening the canal 10 ft. on the upper sides and lining it with concrete. As the average rock cut would be about 28 ft., the difficulty of the work is apparent.

The other plan considered consisted of a tunnel which would reach from the canal headworks to a point some 6000 ft. down the canal. The length of the tunnel was placed at 4000 ft., and the estimated cost was $500,000. It was found that by lowering the present canal bottom about 3 ft. and at this depth reducing the bottom width to 80 ft. and lining the entire section, a water area of about 180 sq.ft. would be secured below a 2-ft. freeboard.

There is sufficient fall in the first two miles of the canal to secure a velocity of 11.1 ft. per second and a canal capacity of 2000 sec.-ft. The cost of carrying out this work is estimated at $135,000 and new improvements are being made in line with this plan (Fig. 5).



FIGS. 6 TO 9. BREAKING THE CANAL WALL INTO SECTIONS AND MOVING IT BACK

Fig. 6—Wall bared in rear and broken into sections. Fig. 7—Broken wall moved to new position. Fig. 8—Pieces of wall set up and joined. Fig. 9—Widened canal

Motor Race-Track at Chicago

SYNOPSIS—This new two-mile automobile speedway is the first to have a wood deck, or track, supported on timber trestling. Rapid construction was a special feature of the work, as not only the track but also buildings, sewers, drains, water supply, etc., had to be provided complete and ready for use in very short time, in order to be ready for races on a given date.

The automobile speedway at Maywood, Ill., just outside the western limits of the City of Chicago, which was opened June 26, is said to be the first to have a timber floor, or track, supported on timber trestling. It proved very satisfactory during the races on the opening day, and the maximum speed attained exceeded any previous records.

The track has a length of two miles on the measuring line (near the inner edge) and consists of two parallel straight sides connected by end curves. Its major and minor axes are about 4053 ft. and 2060 ft. respectively. Because a railway cuts diagonally across one end of the oblong site the end curves or turns are not symmetrical. The north turn has a long curve of 5° 48′ united to the tangents by short spirals. The south turn is composed mainly of two long spirals united by a short length of circular curve. The spirals have 100-ft. chords, with a difference of 38′ 40″ in each station. The long spirals Nos. 1 and 2 reverse at stations 11 and 13 respectively, being symmetrical on opposite sides of these stations, except that the lengths are not the same. The arrangement of the turns and spirals is shown in the table at the bottom of the page.

The instructions for survey work required all tangents to be run out and checked before commencing to run spirals and curves, and points of curves and spirals to be located by measurements from the intersections. All work was to be checked by back deflections, and coördinates measured if further check seemed desirable. Each station was marked by a gas-pipe post driven so deep as not to be disturbed by excavations for footings. The grading excavation was done in advance of the final location measurement.

The width of the track proper is about 65 ft. on the straight, increasing to 75 ft. on the banked turns. Inside of this, on the curves or turns, is an 8-ft. dead space (which is level all the way round). The transverse inclination, or banking, on the turns is about 1 on 3 (or 22°) on the circular curves and runs out on the spirals with a 3% grade along the outer, or high, side. Vertical curves of 150 ft. length connect the ends of this grade with the horizontal portions of the higher and lower ends. The banking is identical at both ends in spite of the difference in curves. This is due to the fact that while, theoretically, a steeper banking would be required for the sharper curves at the south turn, practically, any steeper slope might be unsafe for a car having to slacken speed on the curve.

The banking was designed originally according to accepted formulas for speed and weight, but in construction the results thus obtained were modified on the basis of empirical data and according to the advice of experienced drivers. It was designed for a speed of 75 m.p.h., but the maximum speed record upon it was at the rate of

FIG. 1. THE NORTH TURN OF THE MAYWOOD TWO-MILE AUTOMOBILE SPEEDWAY (NEAR CHICAGO)

The view shows the banked west end of the curve, where it runs (in the foreground) into the level home-stretch. The maximum elevation is about 25 ft. in a width of 75 ft. The floor track is of 2x4-in. timbers, placed on edge

LAYOUT OF THE MAYWOOD AUTOMOBILE SPEEDWAY (CHICAGO)

	Curve	Radius	Cen. Angle	Length, Ft.
Tangent, home stretch....	....	....	.....	1,335
Spiral curve.....	.....	.....	60° 30′	1,400
Circular curve.....	4° 21′ 55″	1312 ft.	29° 29′	675
Spiral curve.....	....	....	90°	1,800
Tangent, back stretch....	....	....	.....	1,450
Spiral curve.....	.....	.....	23° 12′	800
Circular curve.....	5° 48′	988 ft.	133° 19′	2,300
Spiral (to home stretch)..	....	....	23° 12′	800
Total length (two miles).....				10,560

SPIRALS

	No. of Chords	Radius in Feet: Entering	Middle	Leaving
No. 1. From home stretch.	14	8890	(Sta. 11) 808	1111
No. 2. Into back stretch...	18	1111	(Sta. 13) 684	8890
No. 3. From back stretch.	8	8890	.....	1111
No. 4. Into home stretch..	8	1111	.....	8890

over 100 m.p.h. The average speed for the 500-mile race on June 26 was 97.58 m.p.h.

The combined change in longitudinal grade and transverse inclination forms a warped surface, which is given by cutting the supporting posts to carefully calculated lengths.

Near the starting point is the row of 35 supply pits, with a stretch of concrete paving 20 ft. wide between them and the inner side of the track. Here the cars stand while those in charge of them are taking supplies, renewing tires, making repairs, etc.

Particulars of Speedway-Track Construction

The deck, or flooring, of the track consists of longitudinal 2x4-in. tamarack sticks placed on edge. They average about 16 ft. in length, and each course laps the other about 24 in., the line of joints running diagonally across the track. The floor rests on joists 2x12-in., spaced 24 in. c. to c., on the straight stretches. The floor timbers are spiked together at intervals. In case of wear of any one stick, it can be cut out (spikes and all) and a new one dropped into place, the latter being then spiked or toe-nailed from below. With the exception of the track all timbering is of pine.

Concrete pedestals, or footings, 30 in. square and set 3½ ft. below the ground surface extend 12 in. above the ground line and support the framing for the track. There are five rows of these. On the level tangents they are spaced 12 ft. 6 in. c. to c. longitudinally, and carry 8x12-in. stringers upon which the transverse joists are laid. On the turns the pedestals support the posts of transverse bents, as shown. These posts are 10x12 in., each secured to its pedestal by a 1-in. pin 12 in. long. As the bents are placed radially the concreting and carpenter gangs had to be supplied with plans showing the location of the pedestals as well as the elevations of the warped surface of the deck.

Each bent has a cap composed of two 3x12-in. planks framed into the posts; upon these are 3x12-in. stringers spaced 5 ft. 3 in. apart and braced by cleats. Across the stringers are the track joists, 2x10-in., with bridging between them. All bents are thoroughly braced, and along the back and front of the bents is diagonal bracing in every fourth panel, forming braced towers. At intervals of 400 ft. a fire-stop is made by nailing metal lath to both sides of a bent and covering it with plaster. This extends from the ground to the deck.

The posts on the outer, or high, side are extended 20 in. above the track deck, and to their faces is bolted an oak guard timber 6x12 in. Short intermediate posts alternate with the main posts, so that the rail is supported at intervals of 6 ft. 3 in. Along the inner side of the track is a similar guard timber, carried by short posts 6 ft. 3 in. c. to c. These guards are to check any runaway cars. At the grandstand and bleachers a screen of wire netting is erected to stop tires that may be thrown off by speeding cars.

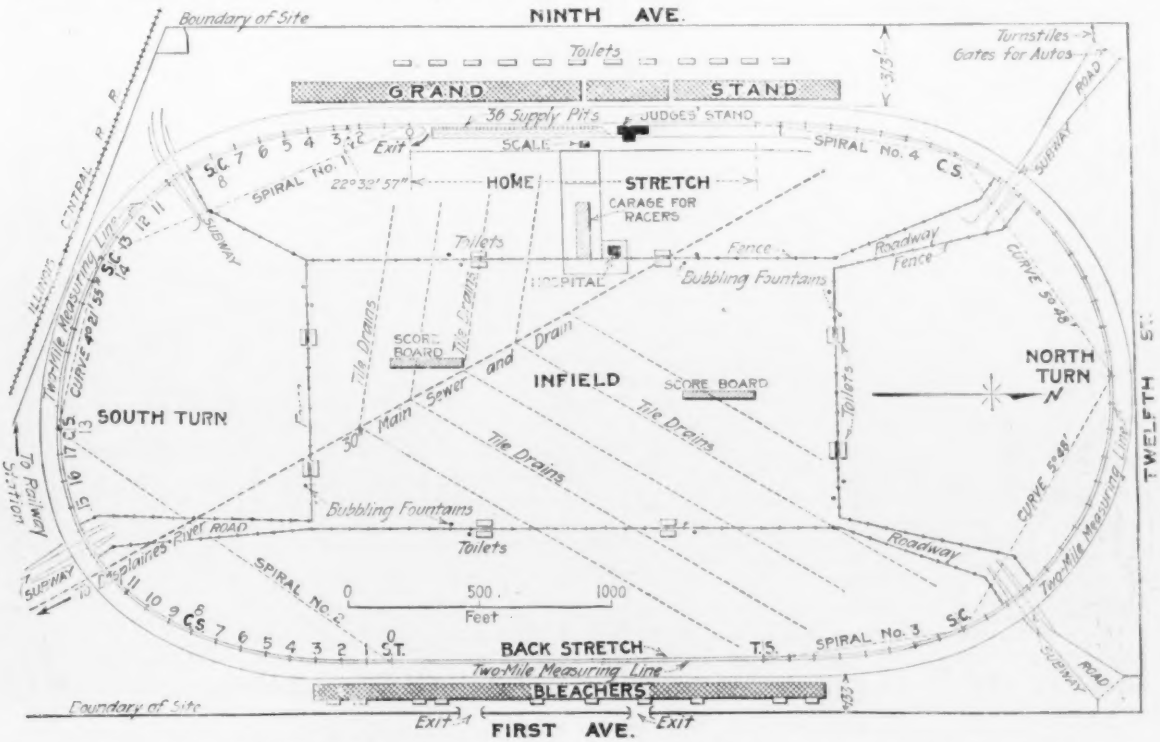


FIG. 2. PLAN OF THE TWO-MILE AUTOMOBILE SPEEDWAY AT MAYWOOD, ILL. (NEAR CHICAGO)
Note the unsymmetrical layout of the two turns, due to the shape of the site

Four subways pass under the turns of track and give access to the infield. Here special construction is required, the spacing between bents being increased to 17 ft. 6 in. for the two driveways. The posts are 12x12 in., with cast-iron caps for a pair of cap timbers 8x18 in. Across these are laid stringers 4x14 in., 45 in. c. to c., upon which the track joists are placed. Each subway has two 15-ft. driveways and two 6-ft. sidewalks at a higher level. The driveways are paved with concrete and have approach grades of 5%. Each is divided by a central concrete curb to keep vehicles in line.

To provide facilities for the accommodation of a crowd of 100,000 people or more was no small part of the work. Water is obtained by connection with the mains of the village of Maywood, a 6-in. main being laid into the grounds. This is under a pressure of 40 lb. and provides fire-protection service. Pipes are laid into all the buildings and along the bleachers and the grandstand, with bubbling fountains at intervals of 250 ft. The 6-in. main extends close around the outside of the track, with fire hydrants 400 ft. apart. There are about five miles of water pipe.

Numerous free toilet rooms are provided, with first-class fixtures. The buildings are of wood, but it is proposed to place concrete floors later. From these toilets extend separate vitrified tile sewers, connecting with a 30-in. main trunk drain discharging into the Desplaines River.

The ground being a heavy black loam, quickly converted into mud, it was necessary to drain the site to keep the roadways and infield serviceable in wet weather. There are about 12 miles of drains, laid out in herringbone fashion, with lines of 5- and 6-in. pipe 200 ft. apart and connecting with the 30-in. main drain running diagonally across the site. The trenches were excavated to a minimum depth of 30 in. by trenching machines and by hand.

To drain the depressed subways, each has a sump in the middle of the roadway (at one end) with a vertical-shaft 2½-in. centrifugal pump driven by a 5-hp. gasoline engine on a platform level with the dead space of the speedway track. Later, these will be operated by electric motors.

The grandstand is 2240 ft. long and seats about 60,000 persons. It has six-post bents 12 ft. c. to c. A steel roof extends for the full length, having trusses 24 ft. apart. These are supported on two rows of posts, the front ends of the trusses extending as cantilevers in order to avoid the use of posts near the front of the grandstand. The "bleacher" stand is 1940 ft. long, and will accommodate about 40,000 persons. Both stands are designed to carry safely a load of 200 lb. per sq.ft., with allowance for movements of crowds. These structures will be dealt with in a separate article.

Scoreboards, Fences and Roadways

Two scoreboards in the infield are conspicuous structures, each being 275 ft. long and 65 ft. high. These were built entirely of wood, owing to the short time available for their construction. They have on each side rows of openings for roller curtains on which are painted figures 4 ft. high. These are operated by men on the inside. The scoreboards show the spectators the progress of the races and the performance or standing of the competitors. A complete telephone system connects the score-men with the time-takers at different points along the course, and with the judges' stand.

A tight board fence 10 ft. high and 3½ miles long surrounds the site. Entrances are provided at three corners, and there are additional exits at intervals. The automobile entrances have four or five gateways 16 ft. wide, with men in charge to collect tickets. A balcony in the entrance structure provides for an inspector, who can watch the movement of the lines of vehicles. To avoid crush, no change is given at the entrance gates for pedestrians. Tickets or the exact fee are handed in at the turnstiles.

The main driveways are of concrete. Those of the infield, etc., are of screenings on a bed of cinders well rolled into the graded and rolled surface of the earth.

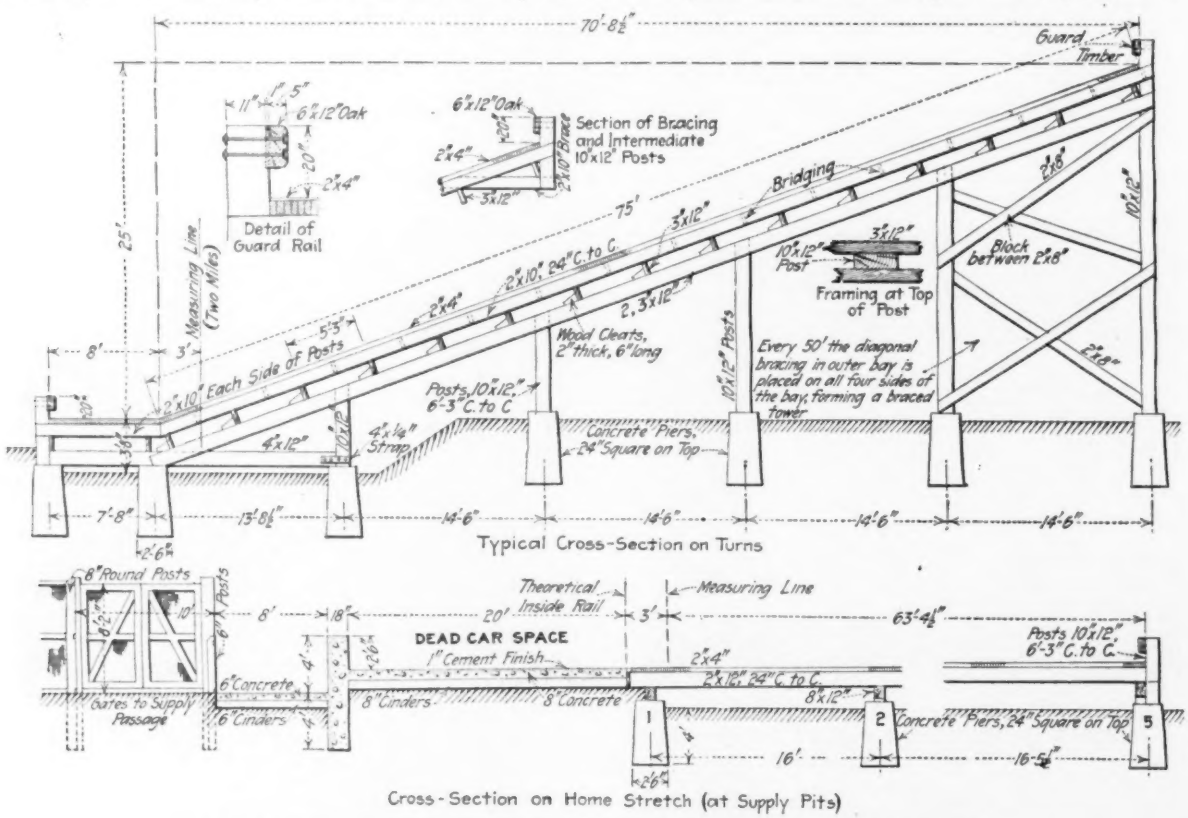

70'-8½"
Guard Timber
Detail of Guard Rail
Section of Bracing and Intermediate 10"x12" Posts
Bridging
Measuring Line (Two Miles)
Block between 2"x8"
Framing at Top of Post
Wood Cleats, 2" thick, 6" long
Every 50' the diagonal bracing in outer bay is placed on all four sides of the bay, forming a braced tower
Concrete Piers, 24" Square on Top
Typical Cross-Section on Turns
8" Round Posts
DEAD CAR SPACE
1" Cement Finish
6" Concrete
8" Cinders
8" Concrete
Gates to Supply Passage
Theoretical Inside Rail
Measuring Line
Posts 10"x12" 6'-3" C. to C.
Concrete Piers, 24" Square on Top
Cross-Section on Home Stretch (at Supply Pits)

FIG. 3. TYPICAL SECTIONS OF THE SPEEDWAY ON TANGENTS AND TURNS

Plank roadways were also provided inside the grounds temporarily. The site was reached by rough gravel and earth roads, and in order to provide for the heavy teaming the contractor was obliged to pave the main approaches with broken stone. These macadam roads were well rolled and later oiled to give a compact surface and avoid a dust nuisance during the heavy automobile traffic on the days of the races.

Details of the Construction Work

The Speedway Park Association let the general contract to the Shank Co., of Chicago. This contract covered all the work (track, buildings, stands, sewerage, water-supply, etc., complete), with instructions to have the speedway ready for the races set for June 19. The material included some 13,500,000 ft. b.m. of timber and 20,000 cu.yd. of concrete. The track alone required 7,000,000 ft. b.m. of timber and 7000 yd. of concrete. The necessity of framing the speedway bents to give the warped surface of the turns made this part of the work relatively slow and difficult. All framing and cutting of timber was done on the site. Material was brought in by wagons and motor trucks, and this traffic made it necessary to keep a repair gang at work to maintain the approach roads in passable condition. A sawmill was erected as part of the plant.

Grading machines were used to level the ground and form the roadways, and a trenching machine excavated the trenches for drains, sewers, and water mains. Post-hole diggers were used to excavate the holes for the concrete pedestals.

For the numerous small pedestals and footings and the concrete roadways, a number of small concrete mixers were used, being shifted from place to place. A part of the time a night shift was worked by the aid of acetylene torches on stands 10 or 12 ft. high. The number of men at work ranged from 500 to 1500.

The contract with the Shank Co. was signed April 19, and work was started April 21. The track was undertaken first and was completed on June 5. A night shift was tried (for placing the 2x4-in. deck only), but a few nights' experience proved this to be inefficient, and it was given up. The actual working time on the track was a little more than a month. In the remaining time all the other work was finished with the exception of 120 ft. of timber construction of the grandstand.

Heavy rains delayed work at the end, but the Chicago street-car strike led to the races being postponed for one week, to June 26, by which time the work was practically completed, except for finishing touches.

The general plans were prepared by Graham, Burnham & Co., of Chicago, architects for the Speedway Park Association. The Shank Co., of Chicago, had the contract for the entire work, and maintained a staff of engineers who laid out, detailed and superintended all the construction work and the structural designs. The president of this company, George H. Shank, personally supervised the work in the field; Frederick Grim was Chief Engineer; Alfred H. Marshall, Principal Assistant Engineer; C. T. McClelland, Field Engineer, and Charles A. Shank, General Superintendent.

The fencing, walks and scoreboards were built by Van De Venter & Rider, as subcontractors. The steelwork for the cantilever roof of the grandstand was built by the Hansell-Elcock Co., but was erected by the general contractor.

With so much work of so many kinds to be done in a short time, and with an absolute time limit (the day of the races), it was important that there should be no delay be-

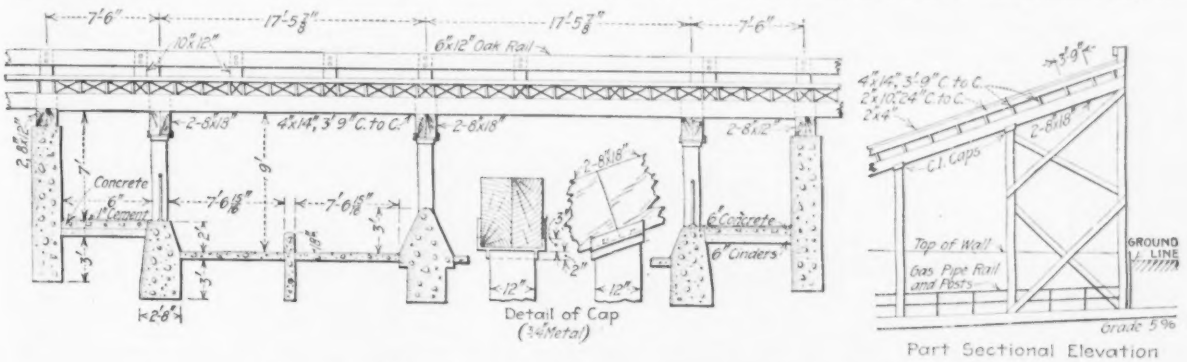


FIG. 4. SUBWAY BENEATH THE TRACK OF THE MAYWOOD SPEEDWAY

cause of friction or misunderstanding between the general contractor and the owners. For this reason C. F. Wiehe, F. N. Foster and D. B. Reid, officials of the Speedway Park Association, composed an Executive Board which advised in all matters of policy and administration.

Manufacturing Portland Cement in Brazil—A government concession to use certain large deposits of shells in the Bay of Bahia, suitable for use in the manufacture of cement, is held by two residents of Bahia, Brazil. United States Consul Robert Frazer, Jr., states that these men claim they can manufacture a first-class cement at a cost of $2.50 to $2.75 per bbl., as against the minimum cost in normal times of $4.32 for an ordinary grade of foreign cement, duty paid. The project includes the erection of a factory in a small harbor opening off the large bay, at a point where steamers can approach to within 100 ft. of the shore. Near this site are large deposits of sea shells mixed with coral and a suitable clay. One of these beds of shells is 1½ mi. long by ¾ mi. wide, and has been tested to a depth of 7½ ft.

A Proposed Standard Box Car of steel construction has been designed by the Committee on Car Construction of the Master Car Builders' Association and was reported at the annual convention at Atlantic City for criticism. The car is of steel construction throughout, with side sheathing of steel sheets ⅛ in. thick and end sheets ¼ in. thick. The cubic volume of the car body under the carlines is 3096 cu.ft. The principal dimensions are as follows:

Length of frame over striking casting	42 ft. 6 in.
Width over sheathing	9 ft. 1⅜ in.
Length, inside	40 ft. 6⅛ in.
Width, inside	8 ft. 6 in.
Height, inside	9 ft. 0 in.
Height, from rail to bottom of bolster	2 ft. 6 in.
Height, from rail to floor	3 ft. 8½ in.
Height, from rail to top of running board	13 ft. 4½ in.
Height, from rail to top of brake staff	14 ft. 2 in.
Width, at eaves	9 ft. 2¾ in.
Height, at eaves	12 ft. 5¾ in.

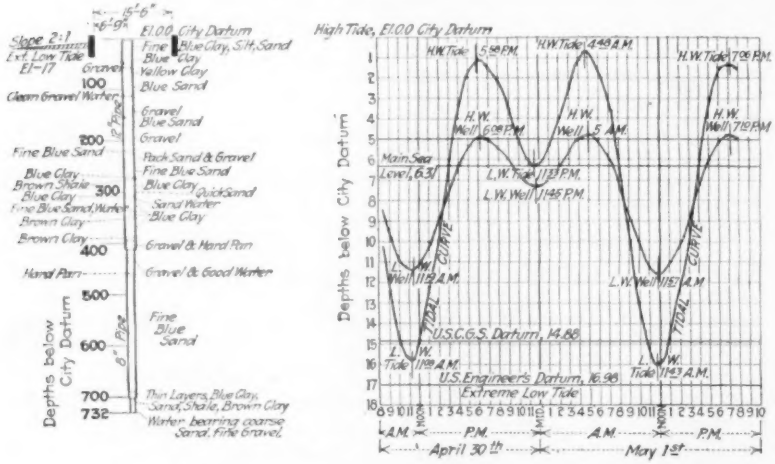
The underframe of the car has been designed to withstand safely a total end force of 250,000 lb.

Tidal Influence on Artesian Well at Seattle

By H. M. Chittenden*

The Port of Seattle has recently sunk a deep well on the shore of Elliott Bay to provide water for a cold-storage plant which it has erected there. The well is 732 ft. deep. It consists of a 12-in. casing down to a depth of 400 ft., an 8-in. casing from that point to a depth of 700 ft., and a 6-in. casing 20 ft. further. No satisfactory supply of water was found until the last water-bearing stratum was pierced. The supply found there is abundant in quantity, satisfactory in quality and entirely fresh. The water rises to the surface of the well without pumping.

A singular fact connected with this well is that it is subject to tidal influence. The water in the casing rises and falls with the tide in the harbor, the oscillations being almost synchronous and the range in the well being nearly 50 per cent. that of the tide. The accompanying diagram shows the well and the strata through which it passes, and also the curves of oscillation in the harbor and in the well. There is no opening in the casing within 400 ft.



TIDAL EFFECT IN WELL ON SEATTLE WATERFRONT

of the bottom of the harbor, while the foot of the tube is nearly twice that distance from salt water. The water from the well is totally different in quality from that in the harbor. A mile or so out from the shore the harbor bottom reaches a depth of some 300 ft., but the slope from the shore is gradual.

It is difficult to account for this tidal effect in the well. It certainly does not come from any direct aqueous communication with the bay. Infiltration through such thickness of strata would be impossible, or if possible, it could not act so quickly. Moreover, the difference in quality of water precludes any such hypothesis. The only explanation which occurs to the writer is that the bed of the harbor rests like a saucer in the stratum of water which furnishes the supply to the well. The vertical pressure on the bed of the harbor varies with the tide from an average of over 3 tons per sq.ft. to an extreme of over 5 tons. It is possible that this change of pressure is communicated through the harbor bed to the water stratum underneath and thus acts on the well. As such a water stratum could hardly be entirely uninterrupted by harder material, and as the harbor bed cannot be wholly elastic, the full effect of change of pressure on the bed could hardly be felt in the stratum of water underneath. This may account for the much smaller oscillation in the well than that of the tide.

*Brigadier-General, U. S. A., retired, 2010 Broadway, N., Seattle, Wash.

Some Provisions of the New Highway Law of Ohio

A revision of the laws governing highway construction and maintenance in Ohio has been accomplished, and on Sept. 5 an entirely new code went into effect. The new law comprises 15 chapters, 305 sections, and occupies 124 pages of text. It is obviously a series of compromises and an attempt to keep as much of the old scheme of highway control as possible, yet there are several distinctive provisions which should advance good roadbuilding in this state, and the most important is better pay for the county road officials.

There are still three partly independent roadbuilding authorities—the township trustees, the county commissioners and the state highway commissioner. Each authority has its own employees, who are rather curiously interrelated, as the following abstract will show. The township trustees hire their own employees directly or through the county highway superintendent, the county commissioners do their work through the county surveyor (highway superintendent), an elective officer, and the highway commissioner, of course, has his own employees.

The following section of the law covers the roads under the jurisdiction of the township trustees:

Township roads shall include all public highways of the state other than state or county roads as herein defined, and the trustees of each township shall maintain all such roads within their respective townships; and provided further, that the county commissioners shall have full power and authority to assist the township trustees in maintaining all such roads, but nothing herein shall prevent the township trustees from improving any road within their respective townships, except as otherwise provided in this act.

The township trustees are authorized to levy taxes not exceeding three mills per dollar for improving, dragging, repairing or maintaining any public road which they may designate. For such work they "direct" the county highway superintendent (county surveyor) to make surveys, plans and specifications, which may or may not be adopted by the trustees. The township trustees may then let contracts for roadwork and appoint some competent person or persons "to act under the general direction of the county highway superintendent," as an inspector. The inspector's pay is not to exceed $4 per diem, and is paid by the township.

Township Highway Authorities

Each township is divided into not less than one nor more than four road districts. For each such district the trustees appoint a township highway superintendent, who, "under the direction of the township trustees," has control of the roads in his district and the keeping of them

in good repair. He is appointed by the trustees to hold office until removed, but his removal may be accomplished either by the trustees or by the county highway superintendent "for incompetence or gross neglect of duty." His compensation is not fixed by law. He is required to make an annual report to the county highway superintendent, and to file a duplicate report with the township trustees. He is also subject to the orders of the county highway superintendent "to attend to any demonstration for the purpose of exhibiting the best method of dragging highways." Otherwise the township superintendent does not appear to be under the immediate supervision of the county superintendent, and there is no provision in the law to prevent the township trustees from reappointing a township superintendent who has been removed by the county superintendent.

County Highway Authorities

County roads are described as follows:

> County roads shall include all roads which have been or may be improved by the county by placing brick, stone, gravel or other roadbuilding material thereon, or heretofore built by the state and not a part of the intercounty or main market system of roads, together with such roads as have been or may be constructed by the township trustees to conform to the standards for county roads as fixed by the county commissioners, and all such roads shall be maintained by the county commissioners.

The board of county commissioners is given authority to construct or improve any road except the intercounty and main market roads (state highways). The county commissioners may coöperate with the township trustees, but nevertheless have jurisdiction over the trustees and may construct or improve roads on their own initiative or on petitions directed to them by land owners. The county commissioners "order" the county surveyor (highway superintendent) to make the necessary surveys, plans and specifications, but "the profile and grade" are subject to approval of the commissioners. The county highway superintendent is then required to make estimates, supervise contracts and do other necessary engineering work.

The law provides that the present elective county surveyors shall be the county highway superintendents. The county highway superintendent is to give his whole time to the county, and his salary is to be computed as follows: "One dollar per mile for each full mile of the first 1000 mi. of public roads in the county, and in addition $10 for each full 1000 of the first 15,000 of the population of the county; $30 per 1000 for each full 1000 of the second 15,000; $25 per 1000 for each full 1000 of the third 15,000; $15 for each full 1000 for the fourth 15,000; and $5 per 1000 for each full 1000 in excess of 60,000." Thus a county of 1500 mi. of roads and 75,000 population would pay its highway superintendent a salary of $1000 + $10 × 15 + $30 × 15 + $25 × 15 + $15 × 15 + $5 × 15 = $2725 per annum.

This salary covers all services for township, county or state (as hereafter described), and is paid out of the county treasury. The county superintendent is allowed necessary expenses and such assistants as the county commissioners see fit to provide.

Where the county superintendent also has charge of the state highways in his county, one-fifth of his salary is paid by the state. The state highway commissioner may or may not designate the county superintendent to take charge of the state highways, but if for any reason he does not do so the county superintendent loses one-fifth of the salary provided for in the foregoing paragraph.

The state highway commissioner may appoint an engineer other than the county superintendent to have charge of the state work in the county. This, however, can apparently be done only after the state highway commissioner has filed with the county commissioners a written statement to the effect that the county superintendent is not qualified to handle the state work; but the county superintendent, being an elective officer, the county commissioners are powerless to remove.

The county superintendent is required to make a report at least once a year to the county commissioners, a copy of the report to be filed with the state highway commissioner. He is also to furnish such special reports as may be called for by the county commissioners or the state highway commissioner, or to attend conferences with the state highway commissioner if necessary. He is also required to make an annual report for the year ending Nov. 15 to the state highway commissioner, a copy of which is filed with the county commissioners. The law does not make it clear whether or not this report shall refer exclusively to state highways; it shall contain "such matter and in such form as may be prescribed by the state highway commissioner."

In general the county highway superintendent seems to be in full charge of all the roadwork in his county. He "may request advice and assistance from the state highway commissioner in all matters relating to his duties," and by the same section of the law "shall be governed in the conduct of his work by the instructions of the state highway commissioner, as issued from time to time for the guidance of county highway superintendents." At the same time the county superintendent "shall from time to time issue such instructions to the township superintendents as he deems best."

Again, it is provided that the county highway superintendent, "under the direction of the state highway commissioner, shall provide for the maintenance and repair of the roads of the county, under such system as may be deemed expedient, so that each section of the highways of the county shall be under proper supervision and be effectively and economically improved, maintained and repaired."

State Highway Authorities

The following section of the law defines the state highway authority:

> State roads shall include such part or parts of the intercounty highways and main market roads as have been or may hereafter be constructed by the state, or which have been or may hereafter be taken over by the state as provided in this act, and such roads shall be maintained by the state highway department.

The state highway department is declared to be established "for the purpose of affording instruction, assistance and coöperation in the construction, improvement, maintenance and repair of the public roads and bridges of the state." The governor appoints the highway commissioner, whose salary is $4000 per annum, and the commissioner appoints three deputy commissioners, whose annual salaries are $3000 per annum. One of the deputies is designated as chief highway engineer.

The law provides that all these deputies must be competent civil engineers, one to be experienced in road con-

struction and improvement, one experienced in road maintenance and repair, and the third experienced in the design, construction, maintenance and repair of culverts and bridges. Their necessary expenses, not exceeding $1200 per annum, are allowed. The highway commissioner may also appoint, within the limits of his appropriation, as many division engineers, superintendents and inspectors as are necessary. The maximum salary of a division engineer is $2500 per annum.

The duties of the state highway commissioner are prescribed as follows:

The state highway commissioner shall have general supervision of the construction, improvement, maintenance and repair of all intercounty highways and main market roads, and the bridges and culverts thereon. He shall aid the county commissioners in establishing, creating and preparing suitable systems of drainage for highways, and advise with them as to the construction, improvement, maintenance and repair of highways; and he shall approve the design, construction, maintenance and repair of all bridges, including superstructure and substructure, and culverts or other improvements on intercounty or main market roads; and in the case of bridges and culverts on other roads, when the estimated cost thereof exceeds $10,000, the plans therefor shall be submitted to and approved by him, before contracts are let therefor. He shall cause plans, specifications and estimates to be prepared for the construction, maintenance or repair of bridges and culverts when so requested by the authorities having charge thereof, and he shall cause to be made surveys, plats, profiles, specifications and estimates for improvements whether upon state, county or township roads. He shall make inquiry in regard to systems of road and bridge construction and maintenance wherever he may deem it advisable and conduct investigations and experiments with reference thereto, and make all examinations, in his opinion, advisable, as to materials for road construction or improvement.

The state highway commissioner or the chief highway engineer "may call upon the county highway superintendent, at any time, to furnish survey maps and any other information that may be required," the information to be furnished in such form as the commissioner requires. The county superintendent, in turn, may call upon the township trustees or township superintendent to furnish a part of the information required by the state highway department.

A Covered Slip and Pier with Gantry Cranes for Handling Lumber

A new idea in the shipping and handling of high-grade mill lumber is being introduced by the Carpenter-O'Brien Co., of Jacksonville, Fla., which has lumber docks at Eastport, Fla., and Staten Island, N. Y. It includes special pier design, special mechanical handling equipment, special steamers, and the handling of lumber in unit packages instead of in loose pieces.

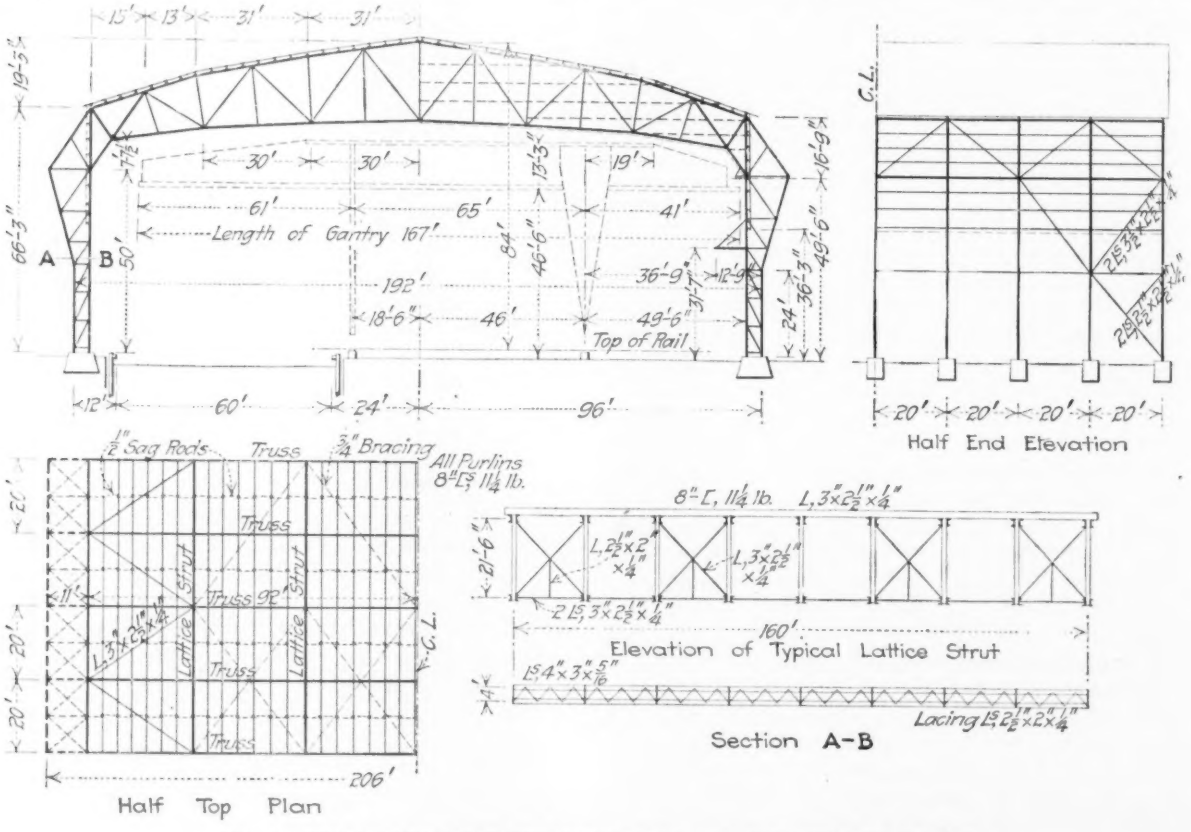


FIG. 1. STEEL SHED OVER STEAMSHIP SLIP AND PIER, STATEN ISLAND

In order to reduce the time of loading and unloading vessels, all lumber will be put up at the Eastport mills in "packages," or units, 4 ft. square and of varying length. These will be carried by a telpher line to a dock equipped with special loading machinery. There they will be placed on steamers having hatches arranged for convenient loading and a hold arranged for suitable stowing of the unit "packages." At Staten Island, the cargo will be unloaded in the same way and the units stored on the dock, to be loaded into barges for distribution as required.

In this way the lumber steamers (like the ore steamers on the Great Lakes) will spend but a small proportion

of their time in port. It is expected that they will make the round trip in eight days—six days at sea and one day in each port.

Another feature is the protection of the lumber (much of it kiln-dried) from rain and snow. For this purpose it will be handled entirely under cover, the pier shed extending over the slip. This arrangement is the same both at Eastport and New York, except that the shed at Staten Island was designed for a snow load in addition to the wind and dead loads, and with unit stresses, etc., as required by the Department of Docks. This design is shown in Fig. 1.

Pier, Shed and Gantries

The slip is 60 ft. wide and is covered by the pier shed for a length of 160 ft. The shed is about 184 ft. wide, with a clear height of about 65 ft. above the floor. Lateral stability of the structure is afforded by lattice columns, which widen toward the upper end and which transmit to the foundation the bending stress due to wind pressure. They are practically vertical trusses whose tops merge with the roof truss, as shown. The columns are spaced 20 ft. c. to c. The frame is sheathed with corrugated iron.

Within the shed are two 20-ton traveling gantry-cranes each 167 ft. long, carried by a tower 65x40 ft., giving cantilever arms of 61 ft. over the slip and 41 ft. at the rear (Fig. 1). There is a single line of rails on each side, and each leg of the tower is carried on two wheels. The maximum load per wheel is 50,000 lb. on the front (or water) side and 65,000 lb. on the rear side. The clear spacing between the legs is 26 ft. at the top, increasing to 40 ft. at the base, so that there is ample room for handling the "packages" of lumber. On the gantry travel two hoisting trolleys. The dock space between and beyond the legs of the gantry tower is available for storage.

The foundations of the dock at Eastport, Fla., are piers composed of groups of piles inclosed in concrete caissons, because of the presence of the teredo in the waters of the St. John River. The caissons are 6x10 ft. in plan, with 12-in. walls reinforced by horizontal and vertical steel bars. The piers on the slip side were constructed first, by sinking the caissons to a depth of at least 26 ft. below the bottom of the slip. The material was dredged out, and eight piles in each caisson were driven to refusal. The caisson was then filled with river sand to within 6½ ft. of the top, the sand being compacted by settling in water. The pier was completed by a heavy concrete cap in which the anchor bolts for the superstructure column were embedded. The piers on the slip side are protected by fender piles. This construction, shown in Fig. 2, was designed by Mr. Cline, of the Carpenter-O'Brien Co.

The foundation design for the Staten Island dock is shown in Fig. 3. After the slip and approach channel have been dredged to 65 ft. of water there remains only 7 ft. for soil over the rock, and the small penetration thus available for pile footings on the side adjacent to the slip creates a special problem. The same condition exists at the opposite side and is corrected here by banking and riprapping, as shown.

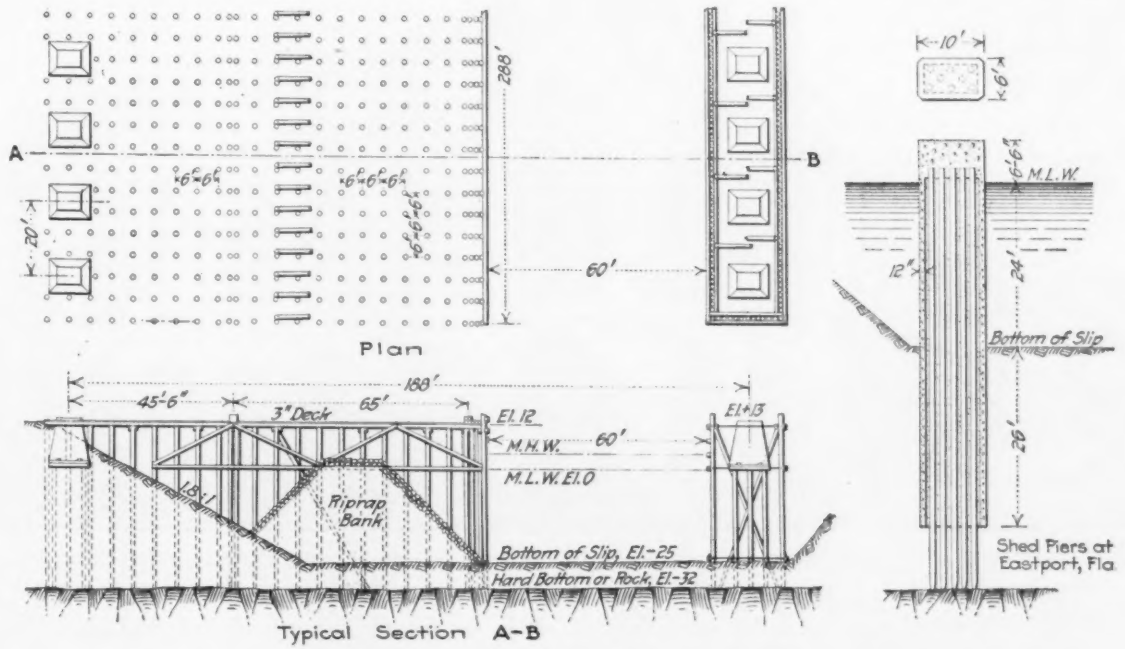


FIG. 2. FOUNDATIONS FOR PIER SHED AND FOR GANTRIES

The shed foundation on the slip side is a rock-filled fender crib with concrete pedestals for the columns. Although excessive thrust of the diagonal cross-timbers is not expected, it is provided for by two lines of longitudinal stringers and rails cross-connected by tie rods. The foundation for the gantries consists of close lines of piling, upon each of which are two tiers of stringers for the rails.

Personnel

The pier sheds were designed and built by the Wisconsin Bridge & Iron Co., of Milwaukee, Wis. The gantry cranes and the telpher system from the mill to the dock at Eastport were built by the Pawling & Harnischfeger Co., of Milwaukee. The steamers were designed by E. S. Hough, consulting marine engineer, San Francisco, Calif.

Double-Deck Freight Station at Pittsburgh

The Pennsylvania R.R. has built at Pittsburgh, Penn., a new freight station and office building (on the North Side) for the Conemaugh Division. The office building, 110x41 ft., is at Federal and No. Canal St., and behind it the station extends 893 ft. along No. Canal to Anderson St. and crossing Sandusky St. Fig. 1 gives a general view of the station, and Figs. 2 and 3 show the construction.

The freight station is a long narrow structure, parallel with the elevated main tracks. The inbound and outbound houses are arranged in line. The former extends 150 ft. from the office building to Sandusky St., and the latter 383 ft. from Sandusky St. to Anderson St. The lower floor is for wagon service and the upper for car service. The latter spans Sandusky St. and has a cantilever projection along the No. Canal St. side.

FIG. 1. OFFICE BUILDING AND DOUBLE-DECK FREIGHT STATION AT PITTSBURGH, PENN.; PENNSYLVANIA R.R. (CONEMAUGH DIVISION)

There are five parallel stub tracks, as shown, each with a capacity of 25 cars. Between tracks Nos. 3 and 4 is an island transfer platform 1000 ft. long. The three outer tracks (Nos. 1 to 3) are for transfer purposes, and the two next the freighthouse (Nos. 4 and 5) are for handling inbound and outbound freight. The island platform is built on concrete pile bents 18 ft. c. to c. Its canopy roof is carried by three lines of I-beams supported by cross-frames on a central row of H-beam columns.

Foundations

The site had been filled with loose materials to an average depth of 15 ft. Concrete walls would have been preferred for the foundations, but their cost was prohibitive. Concrete piles were adopted, different designs being considered in view of the fact that there were timbers and old foundations buried in the fill. It was decided to use piles of the "Simplex" type, poured in place, a cast-iron point and steel shell being driven for each pile. The shell was filled with concrete and then withdrawn and redriven. This type of pile proved very satisfactory, as a number of shells were successfully driven through timber and limestone foundations. While driving through the stonework there was very slight penetration, but on the discovery that the foundations were not resting on a stable base it was decided to drive deeper until proper penetration was reached. Under the conditions at the site it was thought advisable to assure the perfect completion of the piles by having at all times several shells in place between the shell that was being driven and the one that was being poured and withdrawn. There were about 1200 piles, with lengths of 30 to 60 ft.

On account of the removal of the filled material in excavating for the basement of the office building, it was decided to build concrete wall and pillar foundations for that structure. At 8 ft. below the basement level a tough, stable blue clay was encountered, and upon this the foundations were built.

Superstructure and Bridges

The tracks are elevated over Anderson St., and both tracks and station extend over Sandusky St. The streets are spanned by steel-girder bridges of the half-through type, with solid waterproof floors and abutments of concrete. The long subways thus formed are lighted by electricity, and to improve their appearance as well as the lighting, the faces of the abutments and ceilings were finished to a white surface. For the abutments this effect was obtained by depositing a face mortar of 1 part white cement and 1 part marble dust while the other concrete was being placed, so that the white surface finish was monolithic with the abutment concrete. In order to give the walls the appearance of granite stonework, half-round strips were nailed on the forms. Suspended from the bridges are light angle frames carrying steel lath, which is plastered with the above-described mortar.

The frame of the superstructure of the station and office building is of steel. The south side of the structure rests

on a continuous concrete retaining wall, the top of which is some 13 ft. above the elevation of the wagon floor. The north side of the building rests on steel columns 18 ft. c. to c. The columns are of H-beams on cast-iron bases which rest on concrete footings and capped piles.

The width of the wagon floor is 25 ft. at one end, running to 35 ft. at the other end. The width is spanned by built-up girders, which extend as cantilever arms 8 ft.

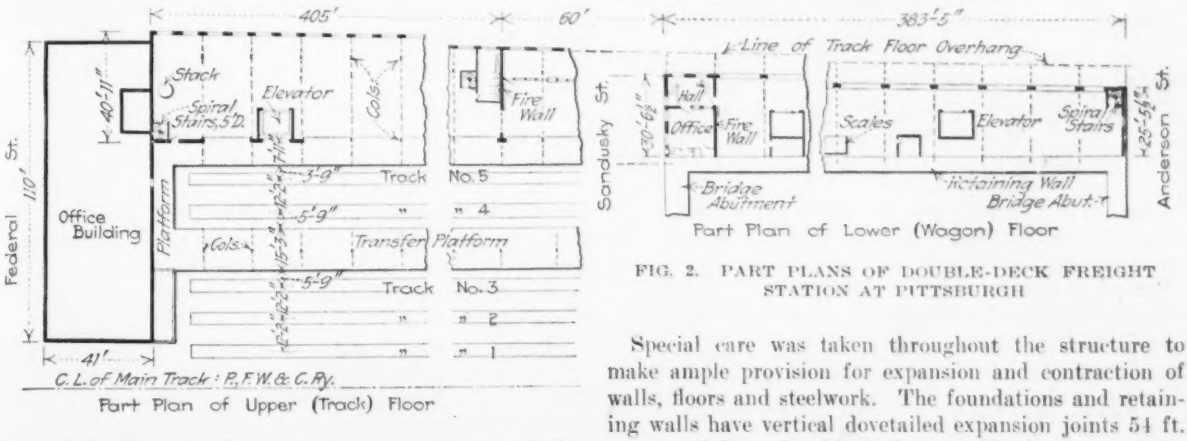


FIG. 2. PART PLANS OF DOUBLE-DECK FREIGHT STATION AT PITTSBURGH

beyond the line of columns, to increase the area of the upper floor and to form a shelter for teams and trucks along the wagon floor. Between the girders are 18-ft. I-beams, which support the reinforced-concrete floor.

The roof of the outbound warehouse is supported on steel trusses, and as there is a contemplated future development in the form of an additional floor in the inbound warehouse, the roof of that part is supported on girders

The wagon floor has a 12-in. base of granulated furnace slag, thoroughly wetted and tamped. Upon this are 4½ in. of concrete and a 1½-in. mastic top dressing hardened by a patent process that was used on all the concrete floors. The track floor has 6 in. of reinforced concrete. The roof consists of reinforced-concrete slabs on which a slag roofing was applied. The warehouse doors are of the steel rolling type. Both floors are divided by brick fire-walls.

Special care was taken throughout the structure to make ample provision for expansion and contraction of walls, floors and steelwork. The foundations and retaining walls have vertical dovetailed expansion joints 54 ft. apart and located midway between the bearings of the girders. The joints were made by bulkheading the forms at every third bay (54 ft.), the amount poured each day. The groove of the joint was molded in each bulkhead, the cross-section dimensions of which equaled one-third of the top width of the wall. The molded groove was faced with tar paper before the next section was built, and in cold weather a greater amount of the paper was used to

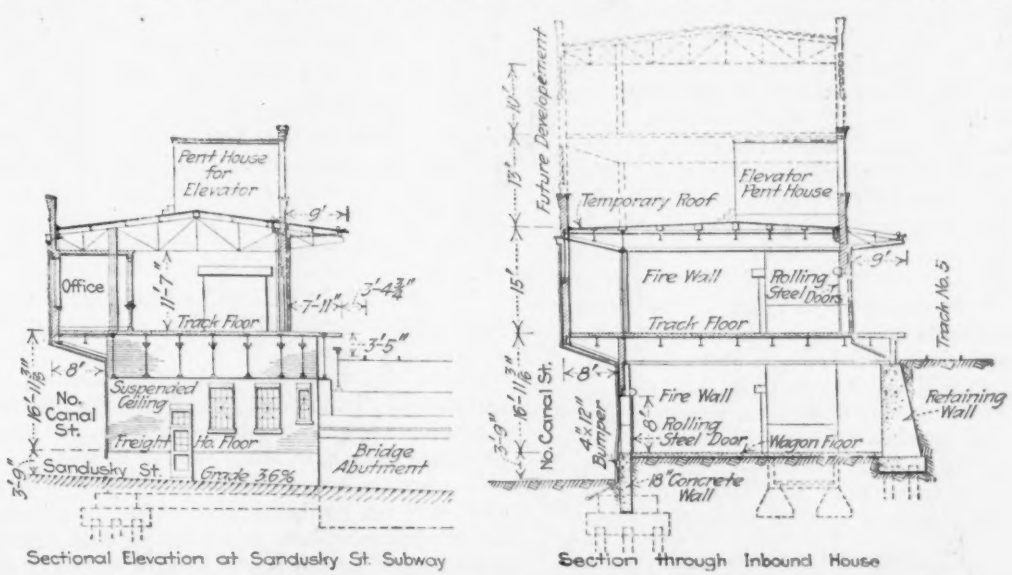


FIG. 3. CROSS-SECTIONS OF DOUBLE-DECK FREIGHT STATIONS; PENNSYLVANIA R.R.

that will later support the additional floor. This is shown in Fig. 3. The steelwork of the office building is similar to that of the freight station. The walls of the latter are of light brick laid in cement mortar, with concrete door sills, lintels and coping. The walls of the office building are of ornamental terra-cotta, and the windows and doors are finished with copper. A circular reinforced-concrete smoke-stack at the rear of the office building is 86 ft. high above the basement elevation.

increase the thickness of the joints. The bridge abutments were cared for in the same manner.

The concrete floors were all made with expansion joints 18 ft. apart. The joints of the reinforced-concrete track floor were made midway between girders, so as to overcome the tendency of cracks in the floor directly over each side of the girders, as the concrete was thinnest at these places owing to the cover plates and rivets of the girders. Special reinforcement was placed in the concrete over the

girders as a further prevention against cracking which would damage the floor. The steelwork was provided with expansion slots at each side of the Sandusky St. bridge. Expansion of brick walls and roof is provided for at the same places as the steel work.

Equipment and Miscellaneous

There are six electric freight elevators of 8500-lb. and two of 12,000-lb. capacity, all equipped with safety gates and having controllers on the cars. Automatic platform scales are provided in both warehouses. Spiral stairs are used, to economize space. Provision is made for electric lighting, steam heating and fire-prevention equipment.

To facilitate the handling of freight between wagons, trucks and platforms, North Canal St. has been regraded and paved with creosoted wood blocks laid on a sand cushion on a concrete base. Changes are made in the grades of Sandusky and Anderson St., to conform to the new grades of North Canal St.

For plans and information *Engineering News* is indebted to J. M. David, Engineer in Charge for the Pennsylvania R.R.

The Boulevard System of San Francisco

By James M. Owens*

Topographically the peninsula of San Francisco offers unequaled opportunities for the development of scenic boulevards—over rolling hilly country, through forests, along the bay shore, around the precipitous cliffs of its famous Golden Gate straits, or skirting the shores of the Pacific Ocean.

Recently a progressive municipal government has completed two of these boulevards; three are in course of construction, and plans have been adopted and funds set aside for others. These boulevards (see map) may be enumerated as follows: (1) Junipero Serra Boulevard (finished), (2) Sloat Boulevard (finished), (3) Portola Drive (75 per cent. finished), (4) Market St. Extension (Corbett Ave. Plan 1) (proposed), (5) Market St. Extension (Plan 2) (proposed), (6) 19th Ave. Boulevard (partly completed), (7) Ocean Boulevard (partly completed), (8) San Bruno Ave. Extension (partly completed), (9) the Great Highway and Esplanade (proposed improvement of).

The construction of the Junipero Serra Boulevard, the first of these scenic boulevards to be built, was briefly described in *Engineering News*, Feb. 18, 1915. Another important link—probably the most important if we consider its relative size and position—is the Sloat Boulevard, extending from Ocean Ave. to the waters of the Pacific, where it connects with the Great Highway.

Sloat Boulevard

The portion of Sloat Boulevard just completed is an asphalt pavement 30 ft. wide and 2.16 mi. long. This strip was designed as part of a proposed boulevard 135 ft. in width, with a double-track electric railroad in the center occupying a 35-ft. right-of-way, with 10-ft. walks on either side and 2-ft. concrete gutters.

Sloat Boulevard as originally constructed was 70 ft. wide, with a 35-ft. railroad right-of-way to the north, leaving a net available width of oiled-macadam roadway of 35 ft. In the design of the new 135-ft. boulevard, of which only a 30-ft. strip could be built at this time, it was thought advisable to use the grade of the old road as near as practicable, to save the old road base, which had become thoroughly compacted by years of travel, as a foundation for the new road. When the necessary property has been obtained on the northerly side of the boulevard the contemplated improvement can be made in its entirety, and will give to the city one of the finest automobile boulevards west of the Rockies.

Portola Drive

Portola Drive is the third link in the city's boulevard system. The construction of this boulevard is practically completed. It has a length of approximately 1.29 mi., a width of roadway of 40 ft., and a grade that does not exceed 5.92 per cent. for fully 90.5 per cent. of its length, and a maximum grade of 7.12 per cent. on the steepest portions of the remainder. Its lowest point is at an elevation of 260 ft. above city datum and its highest at an elevation of 586 ft.

The pavement has armored concrete curbs throughout and storm-water inlets at the various street intersections. The crown is 5 in., the base is of 6 in. of concrete, the asphaltic binder course is 1½ in. thick, and the asphaltic surface coat is 1 in. thick.

The road winds in and out through a forest of eucalypti and pines, with occasional vistas of the Pacific. It is almost devoid of tangents, and in general is made up of long and easy curves. It adjoins some of the finest residential tracts in the city. Along the line of this drive and its future easterly extension are two of the highest points in San Francisco, namely, Mt. Davidson and the Twin Peaks; while close to its westerly end lies the west portal of the Twin Peaks tunnel, just a little to the north.

Market Street Extension

Plan 1—Commencing at the present easterly termination of Portola Drive is a proposed extension which will be known as Corbett Ave. This is a part of the proposed extension under what is known as Plan 1 of Market St. to 24th St., where it will join with the remaining portion of the Market St. extension and continue on to Market St. at 17th St.

The section to be built under Plan 1 will consist of an asphaltic pavement 0.87+ mi. in length and 25 ft. in width. The base will be of concrete 6 in. thick, the asphaltic binder course 1½ in. thick, and the asphaltic surface coat 1 in. thick. A 5-ft. shoulder on the inner side, a 3-ft. concrete gutter, and an armored concrete curb complete the cross-section of the road as planned.

The average grade will be somewhat less than 6 per cent., and the maximum grade, which applies only for a short stretch, will not exceed 7.5 per cent. The highest point reached by this stretch of road will be at elevation 591, and the lowest, 511 ft. above city datum. This will be exceeded in height by only one other proposed boulevard, namely, the scenic drive that is planned to go around Twin Peaks mountain and reservoir. The estimated cost of this section of the Market St. extension, $40,000, is practically assured by the supervisors.

Plan 2—Beginning at 24th St. and joining with the section proposed under Plan 1, a second and final section of the Market St. extension is planned. This in its upper reaches will follow a winding course around the hills and connect with Market St. at 17th St., its extreme easterly

*Assistant City Engineer in charge of pavement design, San Francisco, Calif.

end, close to the east portal of the Twin Peaks tunnel. It is expected that when this link is completed it will be one of the most popular of the scenic boulevards in the entire city, affording as it will from its upper reaches an unsurpassed view of the city, the bay, the bay cities and a portion of the Golden Gate straits. On the other side of the ridge are stretches of forest, occasional clearings and the Pacific Ocean to the west.

Nineteenth Ave. Boulevard

Nineteenth Ave. Boulevard, one of the oldest oiled-macadam boulevards in the city, is being reconstructed to form an asphalt pavement. One contract recently let has been completed, so that there is now a stretch of asphalt pavement 40 ft. wide and 4000 ft. long. There is also being paved a second stretch of 3320 ft., and proceedings are under way to finish the paving of the entire boulevard, which is a little over 2 mi. in length.

This boulevard runs almost due north and south and connects the Sloat Boulevard and Lincoln Way, passing through the Sunset district, one of the largest residential sections in the city. The specifications for paving this boulevard are similar to those of the other boulevards. The estimated cost of these two contracts is $71,940.65.

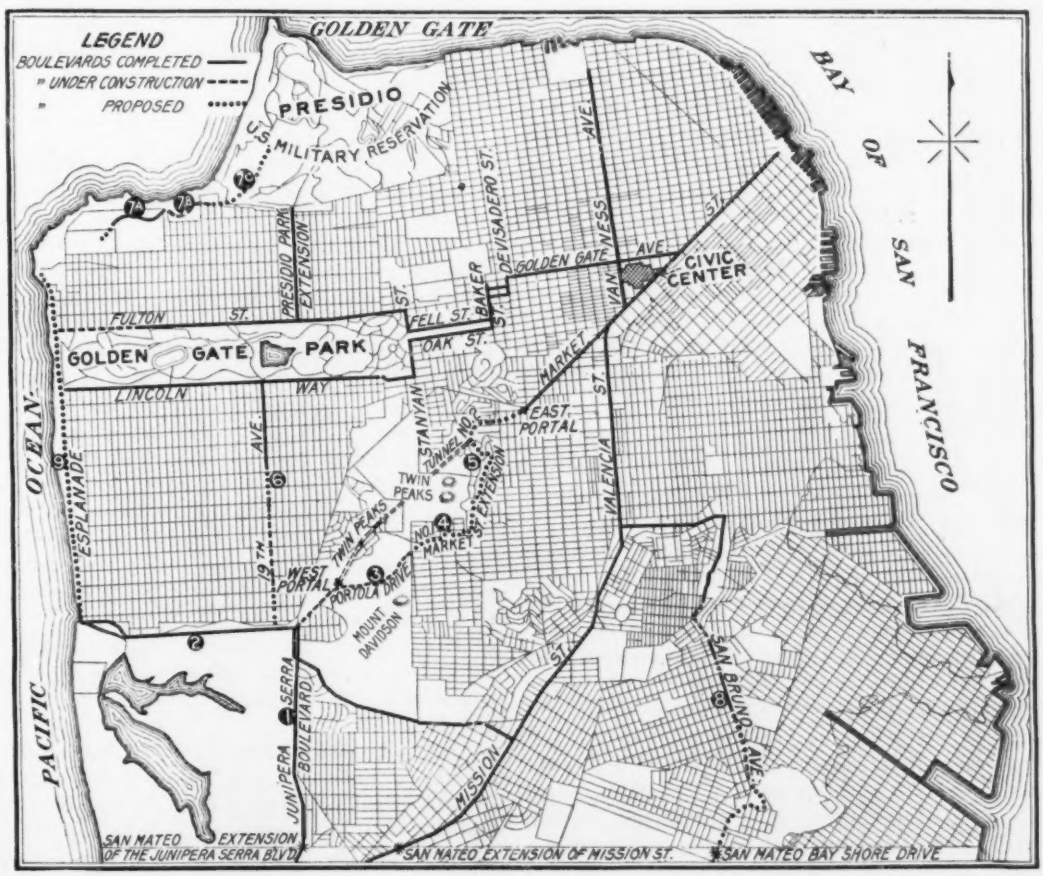
Ocean Boulevard

From the point of view of scenic beauty the boulevard planned for the north shore of the city, already partly constructed through the efforts of the city, the Panama-Pacific International Exposition Co. and the property owners, will probably surpass all the others. Although the alignment has been somewhat changed, the general plan proposed by the city engineer in 1913 very aptly describes the route as follows:

> A proposed Ocean Boulevard connecting the Exposition Grounds with the Cliff House and Ocean Boulevard, following the meanders of the bay shore, passing through the Presidio Reservation by way of Fort Winfield Scott, along Bakers Beach to Lincoln Park, and through Lincoln Park by way of Fort Miley Military Reservation to the Cliff House, thence to the Ocean Beach.

San Bruno Avenue Extension

Contracts have been let for paving and grading almost the entire unfinished portion of San Bruno Ave. so that when completed it will give a fine road to the county line, where it will join the recently completed Bay Shore Boulevard of San Mateo County. This will become a very popular drive, as it will afford egress from the eastern portion of the city, just as Mission St. affords a middle route and the Junipero Serra Boulevard a western exit down the Peninsula.



MAP OF SAN FRANCISCO SHOWING EXISTING AND PROPOSED SYSTEM OF BOULEVARDS

The Esplanade

With the assurance of an appropriation of $50,000 by the supervisors the initial work on the proposed Esplanade along the beach will no doubt soon be inaugurated, and in time the present antiquated and irregular, though scenically beautiful, Great Highway will give way to one of the most popular and elaborate boulevards in the system.

The entire work on this boulevard system is under the supervision of the City Engineer, M. M. O'Shaughnessy.

Building the Earth Embankment for Hill View Reservoir

By Arthur W. Tidd*

SYNOPSIS—Equalizing reservoir for Catskill water-supply system of New York City. Located just north of city line. Article details the method of stripping soil, laying 4-in. inner face, 2-ft. outer face, cleaning up slope and planting outside face.

Hill View reservoir, on the line of the aqueduct for the new Catskill water-supply for New York City, is located just north of the northern limit of the city of New York. It is an equalizing reservoir, the 900,000,000 gal. of water in the reservoir serving to modify the effect of the hourly fluctuation in the rate of draft in relation to the more uniform rate of inflow, and to maintain a nearly uniform head on the distribution system throughout the city. It also affords two or three days' supply in case of an accident to the aqueduct above the reservoir, and provides an ample supply for such an emergency as a large conflagration or a bad break in a street main in the city. The site is at the extreme southerly end of a comparatively narrow ridge, the highest site available for a reservoir in or near the city. By referring to the plan of the reservoir on page 501, noting the elevations of the adjoining property shown and knowing that the axis of the ridge runs from the position of El. 299 to that of El. 253, a very good mental picture of the site can be made.

Nature of Embankment

The reservoir is of the earth embankment type, an excavation having been made in the top of the ridge and the material so obtained placed around the edge of the site to form the reservoir embankment. About 3,000,000 cu.yd. of excavation were involved, the maximum cut being 44 ft. and the average cut 25 ft. The depth of water in the reservoir will be 36½ ft., the capacity about 900,000,000 gal. and the area of water surface about 90 acres. The elevation of the flow line is 295. The reservoir is uncovered and roughly rectangular, about 3000 ft. long and 1500 ft. wide. The formation is a very hard-packed, dense, glacial drift, containing many stones and boulders but no ledge rock. The material is well graded from a coarse sand down to a very fine rock flour, and is a most excellent one for a reservoir embankment. The sides of steam shovel cuts stood perpendicular for two years without change other than the scaling off caused by the action of frost.

The embankment may be described as an earthen dam constructed of carefully selected and thoroughly compacted material, and backed up by the remainder of the excavated material, which equals and in many places exceeds in volume that of the especially treated portion. The embankment on the water side was rolled in layers not thicker than 4 in. when compacted, while in the outer portion 2-ft. layers were allowed. It was on the outer portion that material unsuitable for the special impervious (4-in.) embankment was deposited together with the boulders or stones that the contractor did not elect to use for other purposes. The entire dependence for water-tightness was placed on the 4-in. or special impervious embankment (the former term was commonly used during construction, the latter one being the wording of the contract); the material in situ was impervious and no cutoff wall or core wall was provided. The bottom of the reservoir and the lower half of the inside slope were faced with concrete, but with no intention of providing additional water-tightness. No ledge rock and no springs were encountered in the excavation and no evidences of porous strata were ever observed; in fact, there was no stratification of any kind.

*Assistant Engineer, Board of Water Supply, City of New York, 215 Kimball Ave., Yonkers, N. Y.

Preparation of Base of Embankment

The bonding of the base of the embankment with its foundation was done with extreme care. Portions of the site of the reservoir had been developed, roads laid out and several dwellings built, and there was one area of some 25 acres in use as a farm with house, barns, store houses and various outbuildings. The stripping of the top soil (which was done as a part of the contract) usually uncovered the original material; but around the dwellings a great amount of slow and painstaking work was required. Blind drains, pipe trenches, abandoned sewers, cesspools, and old cisterns were uncovered in the most unexpected places, and large fills of rubbish were found around the barns. Some fills were apparently made from cellar excavations and without careful scrutiny might have passed as material in its original position. All drains and pipes were followed to a terminus, the excavation being carried well below and on each side of the pipe. Over some areas a face cut was carried and the suspicions usually confirmed. As a final precaution before beginning the construction of the embankment, long test trenches were dug to intersect anything overlooked in the previous search.

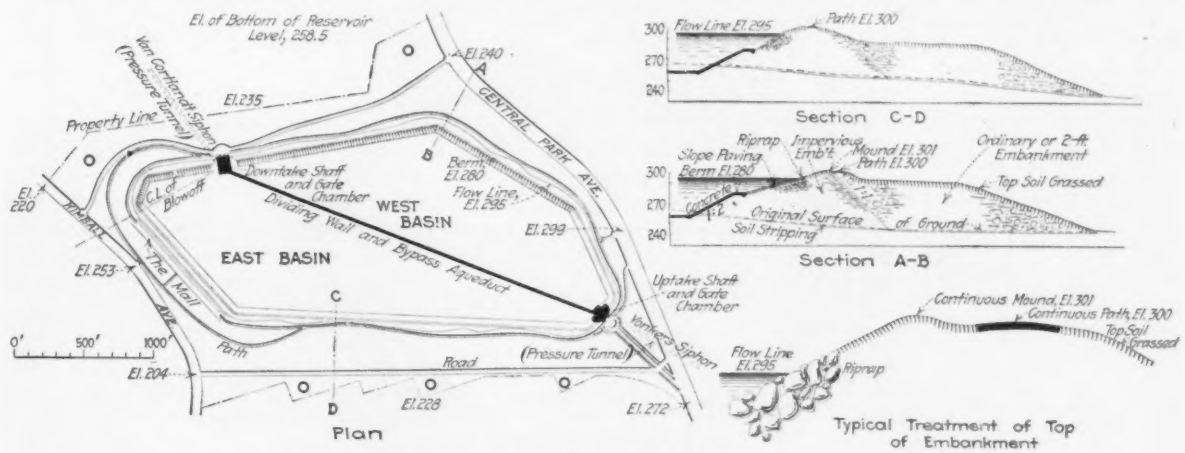
From the finally stripped surface, small boulders and all stumps and large roots were removed. Large firmly embedded boulders were allowed to remain if there was room between them sufficient to operate the 10-ton steam rollers. Trenches were either filled by hand ramming or sloped enough to allow the roller to ride into and across them. Cisterns and the like were generally filled by hand ramming, as it was found that when filled by puddling it would be several weeks before the roller could cross them. Earth was placed around the boulders and rammed until sufficiently mounded to permit the roller to ride up onto them. Similar explorations were made over the base of the 2-ft. embankment.

Building the 4-In. Embankment

The stripped surface under the base of the 4-in. embankment was thoroughly scarified, usually with a road plow, to a depth of 3 or 4 in., and a thin layer of embankment material deposited and rolled. An excellent bond was thus effected between the original and the fresh material, and it may be stated here that this method was

used throughout the entire construction of the embankment whenever work was started on an area that had lain untouched for a time. The 4-in. layers were then started, beginning in the lowest part, keeping the top of the embankment practically level both normal and parallel to the axis of the embankment.

No system could be introduced into the work until a considerable area had been leveled up; the dumping areas were restricted, irregular in shape, disconnected and often obstructed by boulders. As soon as possible, 3-ft. gage track with 65- to 70-lb. rails was laid on the embankment and the material brought on in cars—4-yd. side-dumping cars in 10-car trains hauled by 10- to 15-ton locomotives. The tracks were laid in straight stretches as long as possible; which was nearly 2000 ft. on the two long sides of the reservoir. Two parallel lines of track were used until the embankment became too narrow to accommodate them, that point not being reached, however, until near the top. The trains were dumped in succession along the full length of the track and the material spread and leveled with a spreader-car into a layer about 6 in. thick.



DETAILS OF HILL VIEW RESERVOIR, CATSKILL AQUEDUCT

As soon as the spreader-car had finished, usually in about four trips, the track was pulled away a certain definite distance, lined up exactly parallel to the previous position and was ready for trains again (see view No. 9). The track was pulled approximately into position by three or four teams of horses and then lined up by a track gang, who adjusted the ties and did any necessary spiking and bolting. The amount of the track throw was determined from careful observations taken on the compacted layers, for each layer when spread must just connect with the edge of the previously spread layer and when rolled must be 4 in. thick. The steam-shovel runners became expert in loading the cars to the limit and at the same time with a very uniform volume, for it was on that uniformity of volume that the success of the whole method depended. The system worked admirably and was used for the bulk of the bank. The track throw was in general 14 ft. The spreader-car was not able to spread the full width even when counterweighted, 10 ft. being about its limit, so the remainder was spread with a 4-horse road scraper. A stone gang worked continuously picking out and removing the boulders and stones larger than 3 in., in order to allow the roller to get onto the layer at the earliest possible moment. Here again the steam shovel runners coöperated by avoiding the larger boulders when loading for the 4-in. embankment.

Ten-ton rollers with grooved front wheel and cleated side wheels were used. They were run back and forth parallel to the track, moving over the width of the side wheel (about 18 in.) on each trip, thus making four rollings on each layer. During hot weather, the material required sprinkling to insure proper bonding with the preceding layer and thorough compacting. The watering was done by an ordinary street sprinkling cart drawn by horses, and the water was applied to the rolled layer before the new layer was dumped. A sprinkling car was tried, but given up, as it interfered too much with the regularity of the train movements. Shallow test pits were dug from time to time in the 4-in. embankment to prove the thoroughness of the compacting. The results were entirely satisfactory; the line of demarcation between successive layers could not be detected except where different colored material had been used; the degree of compactness was very uniform. That the bank was practically impervious was evidenced by the behavior of the small ponds of rain water that collected from every storm.

The run of the excavation was constantly watched, but very seldom was there found material unsuitable for use on the 4-in. embankment. Material once worked over, such as trimmings from slopes and temporary road or track embankments when removed, was sent to the 2-ft. embankment, as it was found to be unsuitable for 4-in. work, the physical characteristics having been quite changed by the second handling. Wherever ponds collected after rain, the water and mud were removed before fresh material was deposited. On portions of the bank where no work was being done, the ponds were allowed to evaporate; but all material washed or disturbed in any way was removed before preparing to resume work.

Some difficulty was experienced in securing thorough compacting wherever the direction of track shifting was reversed. This occurred at points where the work of one track connected with the portion of the same horizontal layer placed by the other track and also along the edges of the bank. In such cases it was necessary to place two layers one on top of the other before the track was shifted, and in the rush to take care of the material as fast as it was sent out from the steam shovels, great vigilance was required to insure that the proper amount

BUILDING
the
HILLVIEW RESERVOIR
for
CATSKILL AQUEDUCT
NEW YORK CITY
① Typical cut for large steam shovels
② Excavation operations in progress
③ Building 4-in. embankment (on left) and 2-ft. embankment (on right)
④ Outside slope before smoothing up
⑤ Smoothing up and grading outside slope
⑥ Placing top soil by Koppelcar method
⑦ Outside slope finally graded and top-soiled
⑧ Wheelbarrow seeding machine and roller
⑨ Pulling track on 4-in. embankment
⑩ Spreader car on 4-in. embankment
⑪ 4-in. embankment being built

of rolling was given the under layer. Modifications of the system were of course necessary at such places as temporary roadways, around structures and at the sharper changes of alignment in the embankment. Sometimes a big track shift would be made on a Sunday, leaving a portion of the bank unfinished. Here, the trains were usually supplemented by wagons (see view No. 3); but if of sufficient volume would be handled by a special single track where time could be taken to spot the cars and make the frequent necessary track changes. Altogether, only about 30 per cent. of the material was brought on in wagons. All spreading and leveling of the wagon dump was done with 4-horse road scrapers, after which it was rolled in the usual manner. In general, the bank was kept level as it was built up, but necessary depressions, as where the tracks came up out of the excavation, were left with a very flat slope in all directions. When the depression was filled and wherever the bank was brought up against a sloping surface, the layers were kept horizontal, each one being feathered out to a thin edge when it reached the sloping surface.

With the exception of a few very small local areas in the angles of the two gate chambers, the entire bank was consolidated with 10-ton steam rollers; hand ramming or puddling was done over those areas. No pipes or drains were allowed to be placed anywhere in the bank; all the water impounded in the excavation from storms was pumped out over the top of the embankment until the concrete conduit built for the purpose of draining the reservoir was completed. This conduit was located in the original material well below the base of the embankment, was thoroughly bonded with the sides of the trench excavated for it and provided with several concrete cutoff walls. It was absolutely the only opening through or beneath the embankment, the aqueduct entering and leaving by vertical shafts within the reservoir.

The delay on the 4-in. embankment caused by rain was slight where a systematic effort was made to keep the top on a light grade crosswise to insure a runoff. Where the top did not drain, the last layer would soften, ponds would collect and it might be several days before the bank would be properly dried out and ready to receive fresh material. If work was started before the bank was pretty thoroughly dried out, it soon became of a quaking, rubbery consistence, sinking under the roller and trains and coming to a smooth surface again after they had passed. Additional layers did not improve matters for they promptly developed the same characteristics. Such conditions of compacting were thought to be undesirable and were avoided. Work was continued into the fall as long as the fresh oncoming material would thaw out the frost in the preceding layer, that point being passed when the frost would have set in about an inch during the night. When the frost was entirely out in the spring, as determined by test pits, the bank was carefully scraped down to undisturbed material and work resumed. No especial treatment was given the bank during the winter.

Building the 2-Ft. Embankment

The outside or "2-ft." portion of the reservoir embankment, slightly more in volume than the inside or "4-in." portion and backing it up, so to speak, was built up practically in conjunction with it. When conditions of frost or rain prevented material being placed on the 4-in. bank, the output of the shovels would be sent to the 2-ft. bank with the result that it might be raised above the 4-in. Under favorable conditions, when all efforts were concentrated on the 4-in., that might get ahead of the 2-ft., but the two were never very far apart. The 2-ft. bank was brought up in layers about 2 ft. in thickness, the top being kept roughly horizontal. All material unsuitable for use in the 4-in. work, together with the boulders, was sent to the 2-ft. bank, perishable material of course being excluded. Boulders were not allowed to be nested, a minimum limit of 6 in. of earth in the clear between them being required. No especial consolidation of the layers was required. In general the material was delivered in trains. No such system was developed as on the 4-in. work, although a certain regularity was introduced by sending the entire output of some shovels to this bank. Wagons were used on this bank also, about 30 per cent. being placed by them.

It was somewhat difficult to keep the outer face of the bank to the proper lines. Contours of this face were given on the working drawings, showing a rolling, undulating surface and stakes were set on each 5-ft. contour to bring the bank up roughly in accordance with them. The fact that the contours were not straight lines often necessitated considerable track movement, which was not always properly timed. The inside face of this bank, that is, the junction between the 4-in. and the 2-ft., was a plane surface on a 1 on 1 slope and was readily carried up to line. Work was allowed to extend into the winter until settled freezing temperature obtained. It was not resumed in the spring until test pits showed that all frost was out of the ground.

Settlement of Embankment

No settlement of the 4-in. embankment was ever detected, and from the evidence deduced from concrete structures built upon it and grade stakes given, the settlement must have been extremely slight if any at all. In the 2-ft. embankment, the layers settled about as fast as placed, reaching a condition of equilibrium well within a year after placing, subsequent to which no further settlement was appreciable. The embankment was five years in building.

The relative volume of excavation and embankment could not be determined, as it was impossible to separate the material in excavation between 4-in. and 2-ft. embankment; furthermore no estimate could be made of the volume of the boulders.

Excavation Methods

All the material was excavated by steam shovels and about 70 per cent. sent out on trains (see views Nos. 1 and 2). As long as the complete steam shovel plant could be operated, that is until the bank became so narrow on top that the dumping area was restricted, the material was taken up out of the basin by two tracks, one at the north and one at the south end, using pushing engines when the grade required them. Both lines were relocated and regraded several times as the banks rose. The steam shovels used for the bulk of the excavation were four heavy ones (about 70 tons) and four light ones (about 30 tons). The large shovels worked in the heavy cuts, taking the full cut, 40 ft. at the deepest point, at one time. These cuts were, however, shot ahead of the shovel with black powder. The small shovels took the lighter cuts, and in a few cases ran through in two lifts. The material was handled in 4-yd. side-dumping cars in 10-car trains by 10- to 15-ton

locomotives running on 3-ft. gage track laid with 65- to 70-lb. rails.

A large number of boulders of all sizes up to 1 yd., and in some cases 2 or 3 yd. in volume, were encountered everywhere throughout the cuts and their handling became an important factor in the general excavation problem. The original policy adopted by the contractors was to save them in the basin for future use in paving, riprap or for crushed stone for concrete or road construction, but the accumulation interfered so much with succeeding excavation operations that the following seasons as many as possible were sent out onto the bank either to be buried in the 2-ft. embankment or rolled over the edge for disposal at a more convenient time. A large force using a portable gasoline air-compressor for drilling was employed continuously breaking up boulders. Winter work helped some, but the problem was an ever present and troublesome one. The embankment was designed to take care of the entire volume from the excavation and the work was so done. There was no surplus to be disposed of and no shortage to be made up from outside borrow pits.

The distribution of steam-shovel yardage over the five years' work from 1910 to 1914 inclusive is as follows:

Years of Service	Tons Rating	Total Excavation, Cu.Yd.
1	60	21,600
5	60	600,300
5	70	694,000
4	70	409,900
3	65	249,600
4½	30	277,500
4½	30	176,200
2	30	122,300
4½	30	289,400
		2,840,800

Although monthly outputs ranging from 20,000 to 24,000 cu.yd. per shovel were not uncommon from the large shovels in the early part of the work, the yearly figures shown are much more indicative of the rates that may be useful for future studies. The shovels were in use practically all the time.

Final Grading of Top and Outer Slope

Less than 15 per cent. of the area of the top and outside slope of the embankment was required to be finished to fixed lines and grades, those areas being the paths, the access roads to the gate chambers, the marginal path around the reservoir and the mall at the southerly end. The marginal path was on a level grade with a ridge or mound uniformly one foot higher on the water side to prevent surface water from the path entering the reservoir. No fixed or formal treatment was given the rest of the slopes, in fact every effort was made to avoid such an effect. The grading was done entirely by eye, the slope being treated in long stretches and on broad lines to secure, in so far as possible, the effect of natural hill slopes.

The roads and paths controlled the grading in their vicinity and therefore were graded first together with the laying of all drains for taking care of the surface water. A tentative location had been made and stakes set for them while the bank was being brought up, but the whole question was now studied afresh, using actual cross-sections of the bank. Both horizontal and vertical alignment were modified to minimize the amount of material to be moved and still carry out the proper effect from a landscape point of view. The curves were of long radius and the grades easy. Plows, slip scrapers and hand casting usually sufficed, but some wagon work was necessary at times. The marginal path and mound were brought up with a car dump, but the work was carefully done and was finished principally by hand with some scraper work (see views Nos. 4 and 5).

On the balance of the slope, plows and slip scrapers were used supplemented by a small force of men with hand tools. Very little movement of material longitudinally along the slope was required, the desired effect being obtained usually by rounding off the upper portions and slipping the material down the slope. In many places large gullies had been eroded by the elements during the several seasons that had elapsed while the bank was being built, but in most cases these were filled or leveled by local treatment without the necessity of bringing on additional material. Some of the boulders encountered in the "smoothing up" process were rolled down the slope and removed while many others were buried.

Placing Topsoil on Slope

The bank as finally graded was ready for the placing of topsoil without further treatment. The surface was loose as a result of working over it, and an excellent bond with the soil resulted. A small amount of soil was placed in the fall of 1914, and from the experience of that year, the two methods used for the rest of the work were evolved. The balance of the work was done in 1915. The soil had been stripped from the reservoir site in advance of all other work and deposited in five large piles around the edge of the taking and beyond the toe of the embankment slope, a total amount of about 100,000 cu.yd.

By one method the soil was loaded from the soil pile by hand into 1½-cu.yd. Koppel cars running on a 2-ft. gage industrial track, hauled up the slope with a cable by an electrically operated hoist located at the top of the slope, and dumped and spread by hand (see view No. 6). Two cars were handled at a time. They were hauled from the soil pile to the foot of the incline by a horse. The track was shifted after a section of soil had been deposited the full height of the slope. By running the hoisting rope around a sheave at the head of the incline, the sheave being anchored to a deadman by an adjustable line and moved whenever the track was shifted, the hoisting engine could handle a long stretch of slope from one position.

By the other method the soil was loaded from the soil pile by steam shovel into 4-yd. dump cars running on a 3-ft. gage track, hauled to the top of the slope in six-car trains by two 15-ton locomotives and dumped over the edge of the slope. Previously constructed permanent access roads and paths provided a convenient location for most of the track. From the track the soil was spread down the slope by one-horse slip scrapers. A modification of this method was used on some of the longest slopes whereby each car was dumped into a flat wooden box on runners holding a car-load. The box was hauled down the slope by a hoisting engine located at the foot of the slope, emptied by means of an additional rope from the hoist, and hauled back to the train again to receive the next carload. The soil was handled longitudinally along the slope from the windrow of loads by one-horse slip scrapers as before. By this modification the train was held longer than by the original method, but the scraper haul was much shortened. On all slip-scraper spreading, it was necessary to supplement the scrapers with a small force using hand tools to obtain a uniform depth of soil and a properly finished surface.

The Koppel-car method was economical where the haul was short, as on the east side, but the train method was better adapted to the long hauls.

The thickness of the layer of soil was generally 9 in. measured normal to the slope. The thickness was kept constant by means of short stakes or pegs driven at frequent intervals over the area being covered where soil was placed by the Koppel-car method, but where slip scrapers were used, it was necessary to test the thickness by small test holes.

Planting the Slope

The surface was prepared for seeding by a force with iron garden rakes. On the prepared surface, Bradley's seeding-down manure was spread to the amount of 600 lb. per acre, and the following mixture of grass seed sown:

	Lb.
Kentucky blue grass	10
Rhode Island bent	15
Red top	25
White clover	10
Timothy	5
Total per acre	65

In addition, rye to the amount of 15 lb. per acre was sown on the areas seeded in the fall, but in less amounts or omitted entirely on the spring work. The rye and fertilizer were sown by hand, but the rest was sown by a Thompson wheelbarrow seeder, sowing a swath 13 ft. wide (see view No. 8). After sowing, the soil was lightly raked and then rolled with a light wooden roller about 8 in. in diameter and 6 ft. long. On the slope, a small wheel was bolted to the handle and the roller lowered down and pulled back by a rope. One man could handle it on a short slope, but as most of the slope varied from 100 to 200 ft. in length, a light windlass mounted on a wooden frame was usually used. Two men were required on the windlass and one to guide the roller.

Sprinkling was necessary in the fall of 1914 to supplement the rains, a line of 2-in. pipe being laid with outlets for hose connections. Some revolving lawn sprinklers were used and on some areas a hose and nozzle. In general the grass came quickly and satisfactorily. Some annoyance was caused by weeds coming up from seed brought on from the soil piles.

The grass did not get a good start in places on the area sown in the fall of 1914, and some gullies were cut by the rains during the following winter and spring. There was no sloughing off or sliding of the soil down the slope. Repairs were made by driving down the slope with a wagon, dumping the soil where needed and spreading it with hand tools. The steepest slope was 1 on 2 and that obtained for only a few hundred feet near the downtake chamber, usually the steepest portion was nearer 1 on 3. No berms were built anywhere. The surface water intercepted by roads or paths was led by gutters to catch basins and taken into the drainage system built for the purpose. Gutters were usually paved but were grassed where the grade was light. At the time of writing the results obtained by the above described methods are entirely satisfactory. A small amount of erosion of the fresh top soil occurred during the heaviest storms on the slopes where the grass had not attained a good growth. Repairs were made by a small gang of men carrying sacks of soil, sprinkling it where needed and immediately scattering grass seed.

A previous article (*Engineering News* of Oct. 16, 1913) described the sanitary features of the Hill View reservoir work, quoting the sanitary provisions of the contract and giving in detail the way they were worked out. A large camp was built for the accommodation of the labor force, all wastes were disposed of by incineration or septic tank treatment and a constant supervision maintained over the health and living conditions of the employees. Portable pan closets were provided for the use of the men on the work. They were moved about as needed. One heavy galvanized iron pan, 15x18x8 in., was supplied to each closet. The pans were changed daily and the contents incinerated in a central incinerator.

J. Waldo Smith is Chief Engineer of the Board of Water Supply with Department Engineer Frank E. Winsor and Division Engineer Charles E. Wells in charge in the field. The contractor is the Keystone State Construction Co. of Philadelphia, Penn.

Statistics of the Earnings of Graduate Engineers

The dean of one of the state universities in the Middle West recently undertook an inquiry as to the incomes earned by graduates from the university's engineering school. Until 1905, the engineering instruction in the university was given by a department of civil engineering, but in the latter year a separate college of engineering was organized.

The graduates were asked to give their income derived directly or indirectly from their work as engineers or contractors for each year since graduation up to the present time, so far as they were able to report their income in earlier years from memory or records.

The blank sent to be filled out was inclosed in a blank envelope which was inclosed in an outer addressed envelope so that those compiling the records could not identify the person reporting or even his locality. It is noteworthy that only half a dozen of the graduates reporting were members of the American Society of Civil Engineers.

Replies were received from 46.5 per cent. of all the engineering graduates, and from these replies the statistics in the accompanying table were compiled.

INCOME STATISTICS OF GRADUATES IN ENGINEERING FROM A WESTERN STATE UNIVERSITY

Years Out of College	Number Reporting	Highest Income	Lowest Income	Average Income	Per Cent. Above Average	Per Cent. Below Average
1	166	$4,000	$150	$884	40	60
2	152	7,000	400	1,115	28	72
3	136	4,000	300	1,225	34	66
4	119	4,500	600	1,379	31	69
5	94	5,000	420	1,498	32	68
6	80	4,000	600	1,596	48	52
7	73	3,400	720	1,697	48	52
8	63	5,000	650	1,786	47	53
9	53	7,000	840	1,996	38	62
10	50	8,300	1,020	2,296	30	70
11	43	10,300	800	2,530	28	72
12	34	13,200	800	2,819	26	74
13	35	20,000	900	3,127	21	79
14	30	40,000	900	3,927	13	87
15	31	33,000	1,000	3,884	13	87
16	28	21,800	800	4,252	11	89
17	25	27,500	* ...	3,440	16	84
18	23	37,000	1,000	4,671	13	87
19	21	27,000	1,500	4,663	19	81
20	17	23,000	2,000	5,946	24	76
21	17	33,000	2,100	7,734	29	71
22	16	42,500	2,100	8,006	19	81
23	16	46,000	2,000	7,687	25	75
24	13	33,500	2,100	8,172	23	77
25	10	14,800	2,100	4,630	30	70
26	7	13,500	2,100	4,671	14	86
27	5	19,700	1,500	6,340	20	80
28	5	22,500	1,500	6,980	20	80
29	3	4,200	3,000	3,567	33	67
30	3	4,500	3,000	3,833	67	33
31	3	4,500	3,000	4,075	75	25
32	3	4,500	3,700	3,983	33	67
33	2	5,000	3,700	4,350	50	50
34	1	5,000	5,000	5,000	0	0
35	1	5,000	5,000	5,000	0	0

*Indefinite loss reported for this year.

Field and Office

Efficient Traveling Derrick

The Dravo Contracting Co., Pittsburgh, in its construction work on Ohio River dams and bridge piers, uses many self-contained rotating derricks of an original type. In the company's work these are called "whirler derricks." The drawing, Fig. 1, shows the standard 10-ton derrick as designed and built by the company. The structure is framed of timber and the power comprises a standard hoisting engine and a separate swinging engine. The hoisting engine also takes care of traveling, a line carried ahead and passed around a spool of the engine being used to move the derrick forward on its track.

The derrick comprises an underframe of 10x12 and 12x12, mounted on six small truck-wheels on 14-ft. gage. This underframe carries a circle rail about 16 ft. in diameter. The upper or derrick frame has a similar circle rail on its under side. Between the two rails is a roller or wheel ring held at proper spacing by a circular angle, which also serves as bullwheel for the swinging rope.

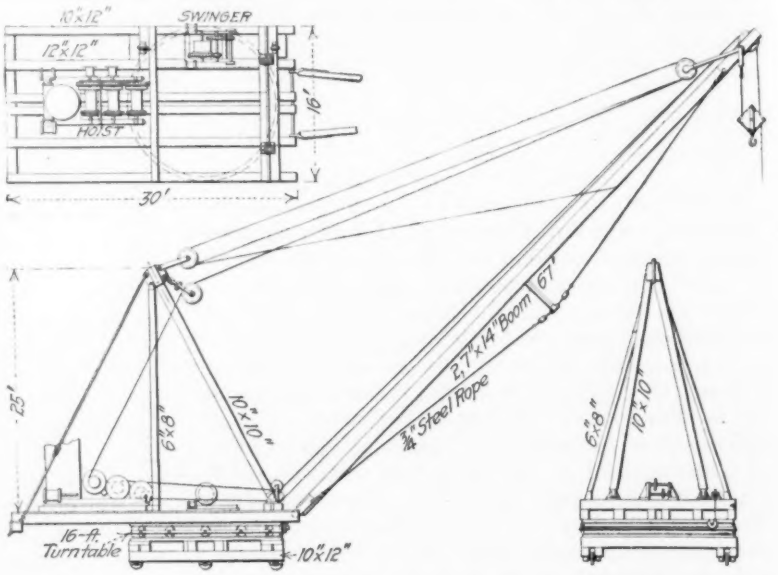


FIG. 1. STANDARD 10-TON WHIRLER DERRICK OF DRAVO CONTRACTING CO.

The mast (inclined) and the boom are both made of two timbers set in A-shape, which gives lateral stiffness in swinging. The boom is journaled on a shaft seated in the forward end of the main frame timbers, and thus transmits its thrust directly back to the tension guys at the rear of the frame.

These machines operate on a short section of track, which is shifted from the rear to the front of the machine as it moves forward. By this ready portability and their simplicity and ease of handling, they prove convenient in a variety of locations, on cribs or coffer-dams as well as on land surface. They are easily dismantled for shipment.

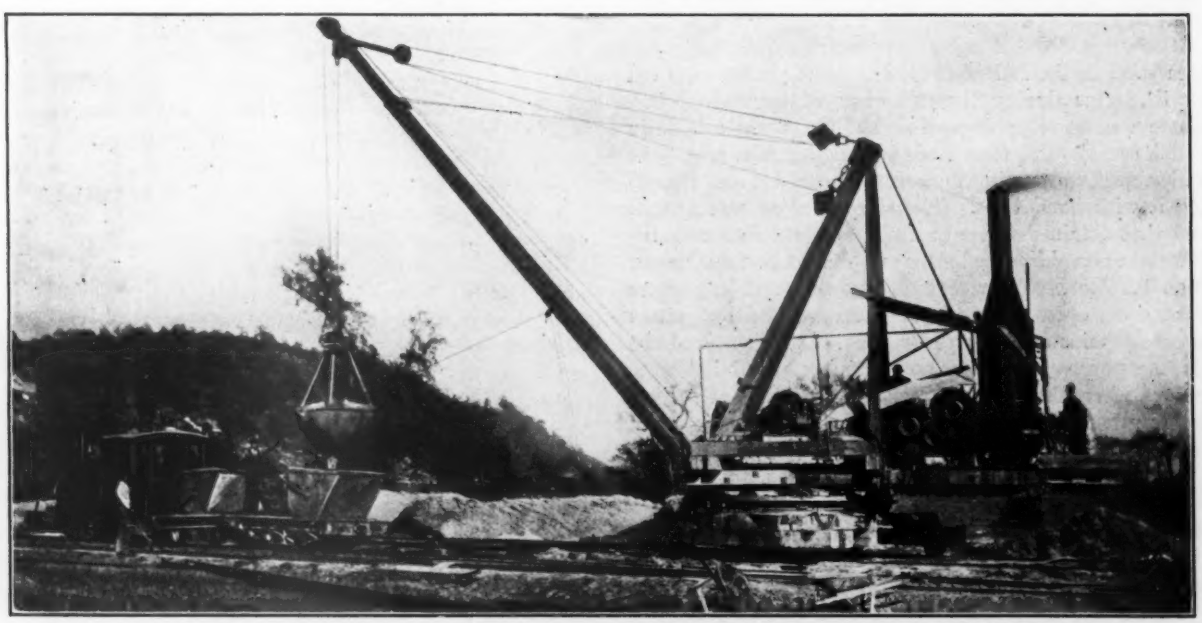


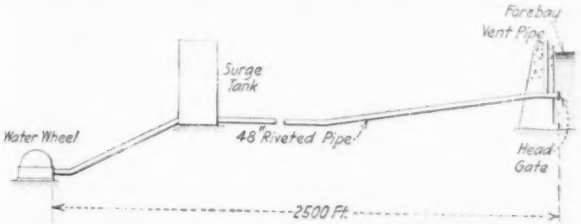
FIG. 2. DRAVO WHIRLER DERRICK ON PIER EXCAVATION FOR SCIOTOVILLE BRIDGE

Opening Headgate Causes Penstock Surges

By W. D. Spengler*

A most unusual and startling case of penstock surges has been dealt with by me, and as the trouble was so extraordinary the details are presented here for professional discussion.

There was a 48-in. penstock about 2500 ft. long laid nearly level for 90 per cent. of its length. There



PENSTOCK WHICH GAVE FILLING SURGES

was a drop of some 15 ft. in the first 100 ft. and a drop of 25 ft. in the last 50 ft. At the intake a 6-in. vent pipe was installed immediately back of the headgate for the specific purpose of furnishing air to the penstock when it was being drained. A head of about 12 ft. was imposed on this gate and the operation of opening was slow and somewhat more difficult than expected, for although 48 in. in diameter, it had no bypass or pilot valve.

In testing the penstock just after erection the foreman proceeded to open this gate and fill the penstock. The gate had been lifted a little, possibly an inch, when an explosion occurred and a spout of water shot out of the vent pipe and up into the air 60 to 80 ft. At the first explosion the foreman had jumped to a place of safety, but after a few seconds he returned and started to open the gate further. Then came a second explosion and water-spout. Without hesitating longer, he stepped to the bank of the ravine where he was safe and from here noted the recurrence of this phenomenon for several minutes. Each succeeding one was less violent, but all

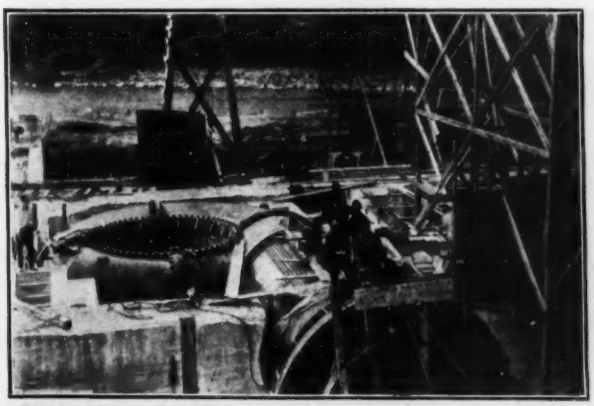


FIG. 1. TURBINE CASING AND STOP VALVE AT ONEIDA PLANT

occurred with regularity. After a time the pipe was filled and the action ceased. Upon examination no damage to the penstock or valve was found to have been done. Inquisitiveness led the foreman to empty the penstock and repeat the operation of filling it. As a rough means of judging of the force of water spouting from the vent pipe, he placed a barrel over the top of the opening. Under the first impulse this barrel was carried fully 50 ft. into the air and fell back over the concrete spillway into the ravine below. The regular series of explosions and spouts was repeated.

Although it may now be seen that the surges were caused by opening the headgate, this result could hardly have been predicted. The incident affords an excellent physical simile of the action of heavy surges in long electric transmission lines.

*606 Citizens Building, Cleveland, Ohio.

Two New Large Johnson Valves

Two 12-ft. Johnson cylindrical stop valves have been installed recently at the Oneida plant of the Utah Power & Light Co., near Phoenix, Utah, to control the admission of water to two 10,000-hp. turbines running under 140-ft. head. These are the largest valves of this type yet made.[1] The Oneida valves are set outside the foundations of the turbine casings to secure minimum size of building. Otherwise the valves would have been connected

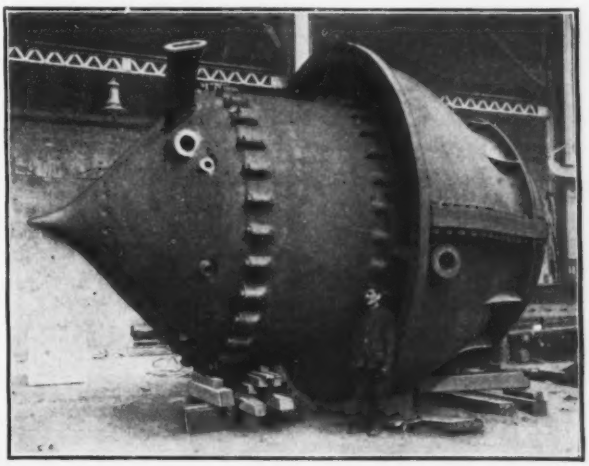


FIG. 2. CAST-STEEL CASINGS FOR 12-FT. JOHNSON VALVE

directly to the turbines. The rear part of the valve casing is of steel plate for economy; the rest is of cast steel, except for the bronze seat and ring.

When the valves are partly open the plungers may become unbalanced by débris and a transverse thrust be set up. Runways with monel-metal faces are provided to guide the plunger and prevent damage from this side thrust. A reach rod attached to the plunger works an outside indicator through a bell-crank shaft in a gland. Besides the indicator pointer, small incandescent lamps show ¼-, ½-, ¾-, and full-closed positions.

After the valve is calibrated it may be used as a venturi meter. The approach and throat ratio is 2:1 compared with 4:1 in the ordinary venturi tubes.

These valves were made by the Wellman-Seaver-Morgan Co., of Cleveland, Ohio.

[1]The design of this type was described in "Engineering News," Dec. 3, 1914. It consists essentially of a cylindrical body, forming an enlargement of the pipe line, with an internal cylindrical chamber containing a plunger of nearly the same diameter. The closed end of the inner chamber and the nose of the plunger are shaped to guide the water smoothly. The plunger seats against a ring in the outer casing.

Enlarging an Old Concrete Retaining-Wall

By George Paaswell*

In rebuilding an old embankment along the White Plains Road extension of the present Bronx subway, it became necessary to utilize the full width of the parcel for trackage on the road. This necessitated increasing the height of the original retaining-wall by about 11 ft. (see Fig. 1). For most of its length the present wall is on piles of which there are three rows, the spacing of the rows (longitudinally) being 3 ft. It was computed that the new wall with backfill would not overstress the piles, but that pending the placing of the earth backing the weight of the wall itself would seriously overload the inner rows of piles. Hence it was deemed advisable to drive another row (shown full in Fig. 1).

The derrick that was used for handling the spoil from the trench for the wall was also used for driving the piles, by a steam hammer working in leads suspended from the derrick boom.

The old wall consisted of 50-ft. sections, and the new wall of course merely extended these sections. The work was prepared for by excavating back of the wall, two sections or 100 ft. at a time. As the embankment was new it required heavy sheeting and timbering. Then the piles were driven.

There was one expansion lock in the old wall, and this lock was carried up through the new wall. The old lock stopped 2 ft. below the top of the old wall and it was necessary to cut out the concrete to reach it and make the pitch filler continuous at the joint. The old coping was removed to about 6 in. from the face of the wall, for architectural reasons and also to insure a better bond. Stonemasons trimmed off the broken part of the coping to obtain a straight line at the junction of the old and new wall.

The footing concrete was poured up to the batter point of the wall and large bond stones were inserted as keys. The forms were then built (see Fig. 2). A platform was built over the middle of the section and a mixer placed at each side. Closed chutes hung from the mouths of the mixers, and sections were added as required in the pouring.

The mixers were of the one-bag-batch type run by gasoline. This wall above the footing contained about 230 cu.yd. per 50-ft. section, and when light permitted we always attempted to pour it in one pour, running from 4 a.m. to 8 p.m. in two shifts. Only in one instance, however, were we successful in doing this. Usually the weather interfered or the mixers broke down. When there was doubt of completing the pour the lift was stopped 1 ft. below the top of the old wall (Fig. 1), a longitudinal timber form being inserted to constitute a key for the upper lift.

The disadvantage of using small-unit mixers lay in the fact that the consistency of the batches varied considerably and the mixer required constant watching to prevent too wet a mix.

The face forms were stripped in 48 hr. and rubbed down. The back forms were left on longer as the sun shone directly on the back of the wall for a large part of the day and the concrete would have dried out too quickly. Although the original part of the wall is over five years old and a different brand of cement was used the wall appears monolithic at a comparatively short distance away.

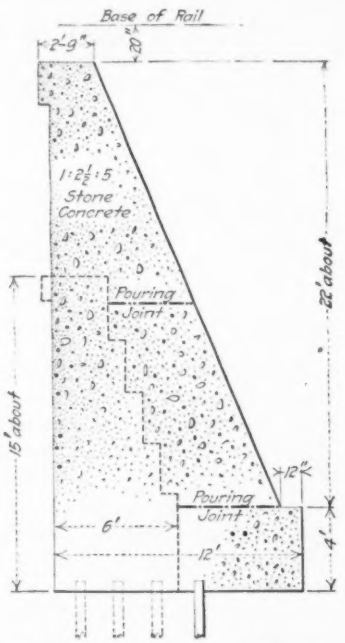


FIG. 1. OLD AND ENLARGED RETAINING-WALL

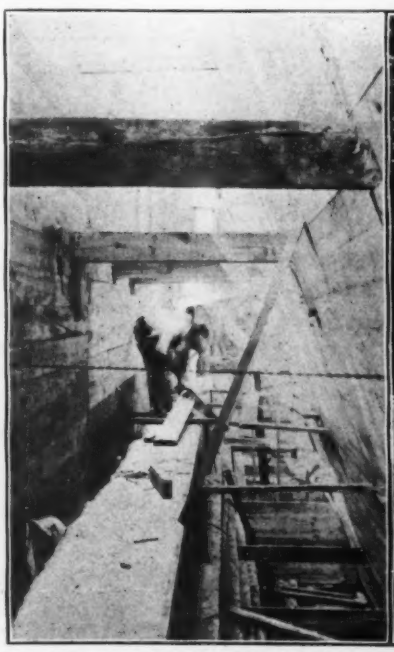


FIG. 2. INSIDE OF WALL FORMS

FIG. 3. COMPLETED SECTION OF WALL

*Section Engineer, Public Service Commission for the First District, New York City.

The entire section of the wall that required enlargement was about 400 ft. long and contained a little over 1100 cu.yd.

The wall was built by the J. B. Malatesta Co., subcontractors for the Oscar Daniels Co., under the supervi-

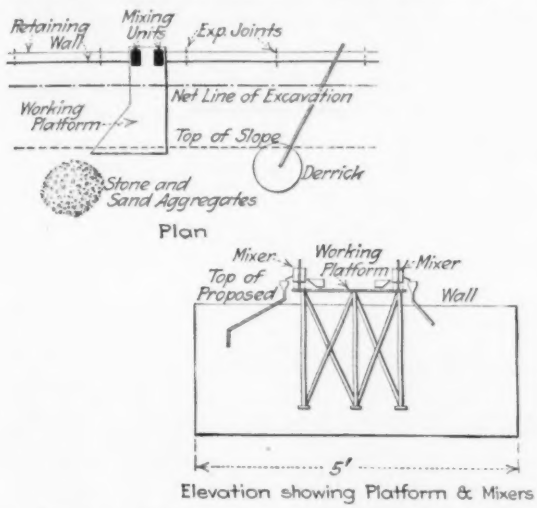


FIG. 4. LOCATION OF TWO-MIXER PLATFORM

sion of the Public Service Commission of the First District. C. V. V. Powers is Division Engineer, A. E. Clark Assistant Division Engineer in charge of all Bronx work, and the writer is section engineer.

Measuring Cement and Water in a Mixing Plant

The troubles that may arise from putting the wrong quantity of cement or water in a concrete batch are avoided by a pair of ingenious devices arranged by Harold E. Ketchum, contractor's superintendent, in the concrete-mixing plant used by the Hunkin-Conkey Construction Co. in building the east half of the Detroit-Superior viaduct, Cleveland.

Tipping Pan for Cement

The concrete is mixed in six-bag batches. Bags of cement are brought by a cable-hauled self-dumping car from the storehouse to the charging platform of the mixer house. The operation of emptying six bags into each charge involves delay, which is important whenever the concrete is being called for at maximum rates—and there is always the chance of the workmen making a mistake in the count, putting too many or too few bags in.

The charging hopper is double, one hopper under the stone gate and one under the sand gate of the bins above. A tipping pan has been set just alongside the sand hopper. The pan holds exactly six bags of loose cement. The cement handlers, therefore, need not count the bags, but simply fill the pan level full, which eliminates the chance of mistake. The pan being filled while the hoppers are discharging into the mixer and being refilled from the bins, it is ready to tip the cement charge into the sand hopper without loss of time.

The arrangement works well. It largely eliminates the necessity of an engineer's inspector on the charging platform.

On the opposite side of the charging hopper is a water barrel with a capacity equal to the water required for a batch. The 2-in. water pipe over the top of this barrel fills it up to a gage mark which defines the quantity needed for a batch. The barrel is tipped into the charging hopper while the stone is going down through into the mixer below.

As compared with the plan of running water by a pipe direct into the mixer, under control of the judgment of the mixerman, this arrangement is obviously superior. It goes a long way toward making successive batches of concrete uniform.

Diagram for Determining Pavement Crowns

By Charles W. Barber*

In determining the proper crown for asphalt- and concrete-paved streets of widths less than 50 ft., the formula, $C = \frac{W\ (100\ -\ 4\ P)}{6300\ +\ 50\ P^2}$ (T. J. Powell, *Trans.* Am. Soc. C.E., Vol. LXXIII, 1911, p. 225) is used by the Engineering Department of the District of Columbia. By combining this formula and the one for rate of transverse grade, $d = \frac{8\ C}{3\ W}$, I obtained $d = \frac{8\ (100\ -\ 4\ P)}{3\ (6300\ +\ 50\ P^2)}$. For this last formula the accompanying diagram, Fig. 1, is plotted.

It will be noted that the formula shows that the transverse grade is dependent upon the longitudinal,

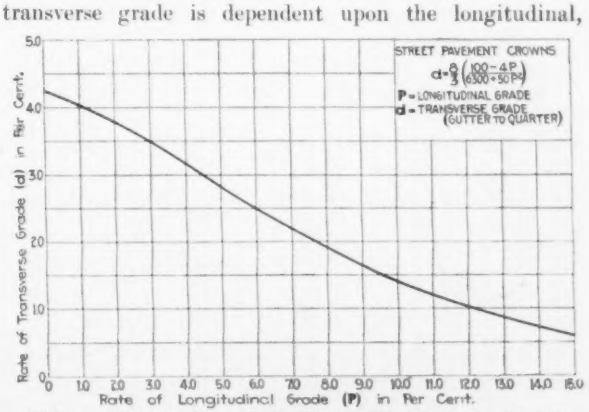


FIG. 1. DIAGRAM FOR DETERMINING CROWNS OF STREET PAVEMENTS

or curb, grade only, and does not include the width of roadway as do other formulas for determining crowns. Consequently the formula is readily adapted to diagram form. The basis of the formula, as mentioned by Mr. Powell in the reference given, is that a vehicle traveling upgrade along a line making an angle of 45 deg. to the curb line, in reality is very nearly on a level plane during the interval between the "quarter"[1] and the curb.

The method by which the transverse grade and crown cross-section are determined will now be shown.

C = Crown, or elevation of center of roadway above gutters;
d = Rate of transeverse grade, gutter to "quarter";
h = Difference in elevation of gutters;
P = Rate of longtitudinal grade (curb grade);
W = Width of roadway;
X = Eccentricity of high point of crown.

*Transitman, Engineer Department, District of Columbia, Washington, D. C.

[1]"Quarter" signifies the points midway between the high point of the crown and the gutters.

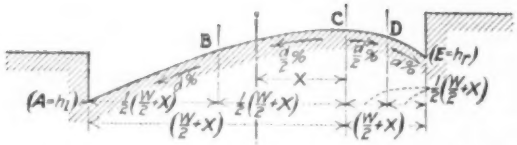


FIG. 2. METHOD OF DETERMINING PAVEMENT CROWNS

$X = \frac{h}{\frac{3}{2}d}$. Elevations are:

$A = h_1$ $\qquad E = h_r$

$B = \frac{1}{2}\left(\frac{W}{2} + X\right)d + h_1$ $\qquad D = h_r + \frac{1}{2}\left(\frac{W}{2} - X\right)d$

$C = B + \frac{1}{2}\left(\frac{W}{2} + X\right)\frac{d}{2}$ $\qquad C = D + \frac{1}{2}\left(\frac{W}{2} - X\right)\frac{d}{2}$

To Use the Diagram—We begin by knowing the rate of longitudinal grade and then trace this ordinate vertically to its intersection with the curve, which point we then trace horizontally to the left, where we read the rate of tranverse grade d.

Crown Cross-Section—The accompanying Fig. 2 and equations indicate the general method in which the crown cross-section is obtained. It should be noticed that when the curbs are level $X = O$, and the high point of the crown is on the center line of the roadway.

Width of roadway (W)	=	30.00 ft.
Width of gutters	=	1.15 ft.
Elevation of left curb	=	86.67 ft.
Elevation of right curb	=	90.08 ft.
Rate of longtitudinal grade (P)	=	3.25 per cent.
Rise of gutter	=	0.10 ft.
Height of curb	=	0.52 ft.

Starting on the chart at $P = 3.25$, we find that this ordinate intersects the curve at $d = 3.40$ per cent. Our computations will be as follows (Fig. 3):

$$h = (90.08 - 89.67) = 0.41$$

$$X = \frac{0.41}{\frac{3}{2} \times 3.40} = 8.04$$

Subtracting the width of the gutter, W becomes $(30.00 - 2x1.15) = 27.70$

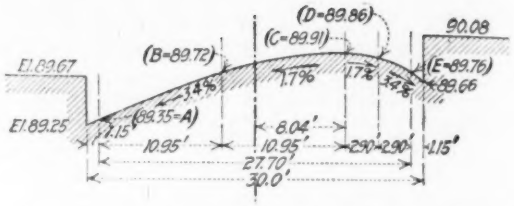


FIG. 3. ILLUSTRATING APPLICATION OF FORMULA AND DIAGRAM

Then

$$\frac{W}{2} = 13.85$$

$$X = 8.04$$

$$\frac{W}{2} - X = 5.81$$

$$\frac{W}{2} + X = 21.91$$

$\frac{1}{2}\left(\frac{W}{2} + X\right)$		$\frac{1}{2}\left(\frac{W}{2} - X\right)$	
10.95	10.95	2.90	2.90
0.0340	0.0170	0.034	0.017
0.3723	0.1862	0.0986	0.0493

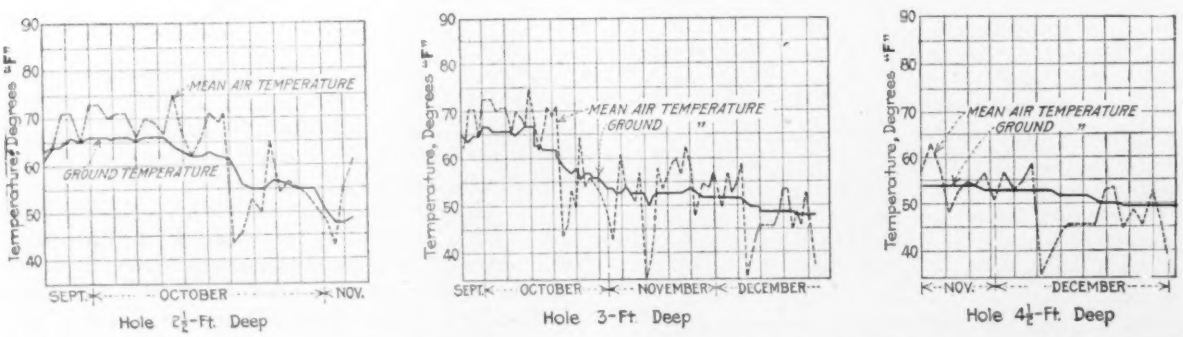
Elevations:

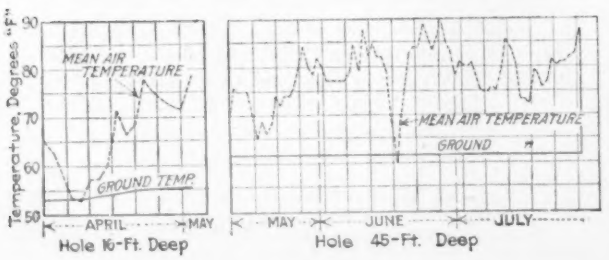
A = 89.35	E = 89.76
0.37	0.10
B = 89.72	D = 89.86
0.19	0.05
C = 89.91	C = 89.91

Ground Temperature Variations Decrease with Depth

By E. Lauchli*

In the notes on the design and construction of a reinforced-concrete dike dam at Mathis, Ga., in *Engineering News*, Sept. 2, 1915, was described the use of extra rein-





COMPARISON OF GROUND AND AIR TEMPERATURES IN BORE HOLES AT MATHIS, GA.

forcing steel in the cutoff wall made advisable to care for local stresses set up by the temperature changes at different depths.

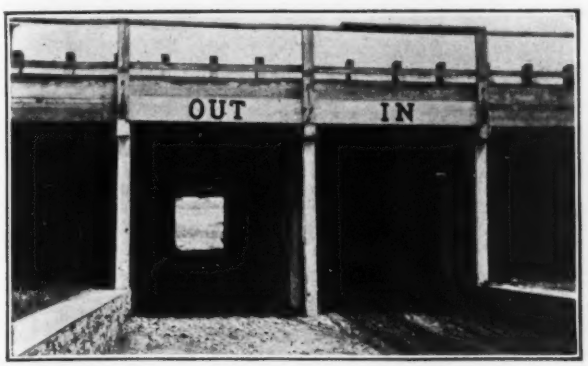
The accompanying curves show the result of the studies, undertaken in connection with this work, to

*2 Wall St., New York City.

ascertain the variation between ground and air temperature in various bore-holes of 2½ to 45 ft. depth. The curves require no explanation except perhaps to note that the ground temperature in the 45-ft. hole was the same throughout the year.

NOTES

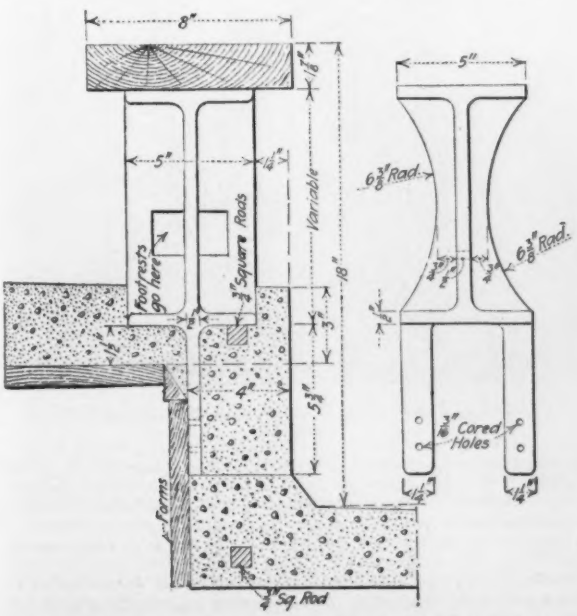
A Durable Timber Bridge is shown in the accompanying illustration. In spite of the fact that it carries an earth fill from 12 to 18 in. deep, it is sound and watertight. It was built in 1892 to form a subway under the Narragansett Park racetrack, near Providence, R. I. For many years this was a famous horse-racing track. It has been converted into an automobile speedway. The bridge is in 4 spans of about 8 ft. each.



A 23-YR.-OLD TIMBER BRIDGE WITH AN EARTH FILL AND A WATERTIGHT FLOOR

The 4x10-in. floor joists, spaced 2 ft. apart, are carried on 6x8-in. timber caps on rows of 6x8 in. posts. The floor is 3x10-in. planks, over which are four thicknesses of tar paper plastered on with hot tar. On top of this floor is the earth fill of the racetrack. The timbers are genuine long-leaf yellow pine and are as sound today as they were 23 yr. ago, and the floor is water-tight. Frederick E. Perkins in president of the Narragansett Park speedway.

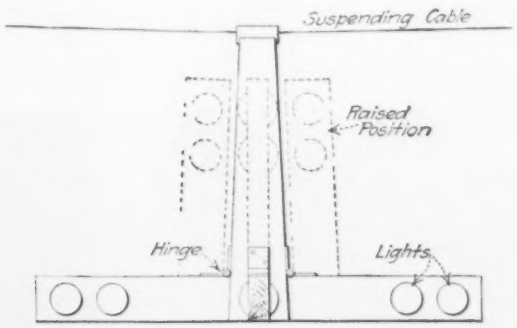
Cast-Iron Standards for Ball-Park Seats are being installed in the open stands and the bleachers of the new National League park on Commonwealth Ave. in Boston, Mass.



SEAT STANDARDS IN NEW BOSTON BALL PARK

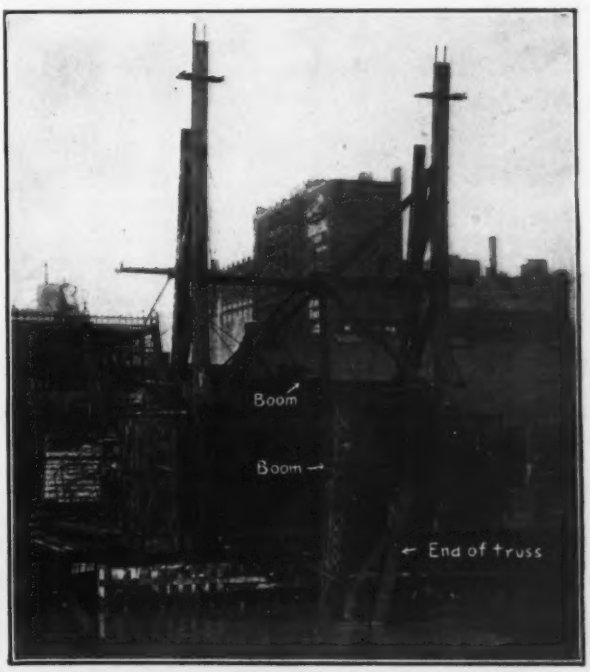
The stands in this park are of reinforced concrete, and in all of the open stands the seats are 2x8-in. plank screwed onto malleable cost-iron standards spaced every 3 ft. and embedded in the concrete of the steps during construction. About 12,000 of these standards are being used. The park structures were designed by the Osborn Engineering Co., of Cleveland, Ohio, and are being built by the James E. Gaffney Co., of Boston.

A Semaphore Type of Street Signal invented by a Cleveland policeman named Ketchum is being tried out in that city at the intersection of Euclid Ave. and East 9th St. Two cables are stretched from poles in diagonally opposite corners of the sidewalks. Hung from the wire cables at their intersections is a post about 3 ft. long, with arms



about 2 ft. long hinged near the bottom of the mast, as shown in the accompanying sketch. The signal is manually controlled by a policeman in a sidewalk booth. From levers here wires run to the signal, one for each blade or arm. The arms may be operated separately for left-hand turns, or in pairs for traffic moving along one street across the other and for right-hand turns. In addition to the position indication, in each arm is a red and a white light.

Failure of a Derrick on Bridge Erection—The fracture of a derrick iron caused the fall of a derrick, Aug. 25, while erecting the west leaf of the bascule bridge over the Chicago River at Jackson St., Chicago, Ill. The erection was illustrated



FALL OF A DERRICK WHILE ERECTING THE JACKSON ST. BRIDGE AT CHICAGO

in "Engineering News," July 22, 1915, but since that view was taken the leaf had been raised to a more nearly vertical position to keep its end clear of the channel. The derrick was placing a 22-ton section comprising the end panel of one truss

and a heavy transverse plate girder. The derrick iron holding the head of the mast to the stiff-legs broke, allowing the weight to pull the mast over. The steel boom fell across the completed work and doubled up, its main portion standing vertically with its head in the river. This is shown in the accompanying view, taken after the boom had been cut apart. The end of the truss panel is projecting above the water. The plate-girder was badly bent when recovered, being hauled up by means of tackle attached to the bridge.

Laying a Water Main Through a Storm Sewer—In the construction of an extension to the high-service fire-protection system of Boston, Mass., it was necessary to lay a 30-in. cast-iron pipe at right angles to a storm-water sewer having an internal diameter of 8 ft. As the top of this sewer was only 4 ft. from the surface of the street, which would allow insufficient cover for the water main, the sewer top was broken into and the main carried through the top of the sewer. To make a neat job and to create as little resistance as possible to the flow through the storm-water sewer, a

LAYING WATER MAIN THROUGH TOP OF SEWER

cast-iron cradle was designed to fit the diameter of the water main. This cradle rested upon the arch ring of the sewer where the latter was broken into. The accompanying view shows the main resting in the cradle. By the means described 28 in. of cover were secured over the water main. The bottom of the cast-iron saddle reached into the storm-water sewer a distance of 15 in. below the highest point of the crown of the arch.—F. I. Winslow, Engineer of Extension, Boston Water-Works.

The Great Northern Ry. Tunnel, 1733 ft. long, near Paola, Mont., with the exception of 500 ft. at the west end, was driven by the use of pneumatic-hammer drills of the "Jackhamer" type. The tunnel is 36 ft. wide and 32 ft. high, having a cross-section of 38 cu.yd. per lin.ft. The material is a sedimentary rock similar to soapstone in texture, but considerably harder. This rock is in strata inclined at 20 deg. to the horizontal and is very seamy and full of mud pockets. Water was frequently encountered. In the wall-plate drifts two 5-ft. rounds per 10-hr. shift could be driven, 14 holes 6 ft. deep to the round. This was possible because drilling could be resumed immediately after shooting, without loss of time in setting up bars and "mucking back." The rock remaining in the heading above the drifts was shot down upon traps erected in the drifts. A round here consisted of from 18 to 22 holes 10 ft. deep, which were drilled in from 3 to 4 hr. with two "Jackhamers." Ordinarily, drilling and mucking were completed in a half-shift. The most remarkable performance of the drills was shooting the bench ahead of the shovel. The "old timers" laughed at the idea and prophesied that tripod drills would have to be used. The bench contained 30 cu.yd. per lin.ft., and was excavated and timbered at an average rate of 20 lin.ft. per day. In order to break up this material, 60 to 70 holes 11 ft. deep were necessary. These were drilled with three or four "Jackhamers" regularly in 7 hr. An 11-ft. hole was frequently drilled in 10 min. The bench holes were drilled from the face because of insufficient overhead room to drill down holes. This prevented the drilling and the shovel excavation being carried on simultaneously.—H. King, of the Guthrie, McDougall Co., Paola, Mont.

Short Cuts in Surveying Computations—In examining the table on p. 363 of "Engineering News" of Aug. 19, 1915, I have been impressed with the conviction that a division by 43,560 can more easily be effected by the use of its reciprocal as a multiplier. If a given number of square feet is multiplied by 0.0000229568 the result will give acres and decimals. More conveniently this rule can be applied: Multiply square feet by 23 and point off 6 places, and multiply square feet by 43 and point off 9 places. Subtract the second product from the first and the result will give area in acres to a degree of precision within 0.001 acre in 100 acres. As an example:

4,356,000 sq. ft.		
× 23 and point off 6 places	=	100.188000
× 43 and point off 9 places	=	0.186908000
		100.001 acres

If greater precision is desired, instead of 43 use 432 as a multiplier for the subtractive quantity, pointing off in that case 10 places. Evidently, areas less than 10 acres may be obtained within a precision of 0.001 acre by using 4 as a multiplier instead of 43 and then pointing off only 8 places. Such a rule may be easily memorized or written in a notebook.—Horace Andrews, Albany, N. Y.

Conveying Automobile Parts by Wire-Rope Tramway between departments 780 ft. distant is now accomplished at Plant No. 3 of the Studebaker Corporation, Detroit, Mich. The carrier cable is 1¼ in. in diameter, the longest span being 178 ft. The traction cable is operated by a 10-hp. electric motor. The system is shown in operation in the accompanying view. By this means automobile bodies and wheels are sent to the

CABLE SYSTEM FOR TRANSPORTING AUTOMOBILE PARTS

assembling department. Formerly, these parts were taken down an elevator from the third floor of the finishing department, trucked through a tunnel to the assembling building, and there elevated to the fourth floor. By the old method 12 min. was required for delivery of a body, with four men to handle it en route. By the new method two men at each terminal tend the conveyor, and as many as 41 bodies have been delivered in 42 min. Steel trestles support the cables; at the buildings it was found necessary to erect steelwork from the ground to the proper height, to take the pull.

Editorials

Examinations for Commissions, Corps of Engineers

It was announced in *Engineering News* of Aug. 12 that a very, very narrow door had been again opened through which engineers who had graduated from other engineering schools than West Point might obtain positions in the Corps of Engineers, U. S. A. The official announcement of the examinations for such appointment, which will be held about Oct. 25, confirms the opinion then expressed that the door opened is so narrow that only an engineering graduate of very unusual ability will be at all likely to succeed in forcing his way through it.

In the first place, as already noted, candidates had first to take the examination for "Junior Engineer," in the engineer department at large. Those taking these examinations, which were held on Aug. 25 and 26, were required to have had "at least four years good civil, mechanical or electrical engineering experience," or to have graduated in engineering from an approved school. This examination for Junior Engineer occupied two days and it was announced that it would include nothing which was not covered by the courses in engineering given by reputable technical schools.

Those passing this examination who are graduates from an approved technical school, are between 21 and 29 years of age and are unmarried will be eligible to take the examination to be held by the War Department on Oct. 25 for a probational appointment as second lieutenant in the Corps of Engineers. The subjects covered in this examination are as follows: (1) English grammar and orthography; (2) elementary French, German or Spanish; (3) an optional subject to be selected by the candidate from a list submitted; (4) physics, including electricity and magnetism, sound and light; (5) chemistry, geology and mineralogy; (6) topographic, hydrographic and geodetic surveying, including the elements of practical astronomy; (7) descriptive geometry and drawing; (8) theoretical and applied mechanics; (9) theory and practice of engineering construction. It is noteworthy that subject 8 is given a relative rating of 18 and subject 9 of 30, while the first three points have relative ratings of only 4.

A candidate must pass a physical examination prior to the written examination, and also submit testimonials as to his moral character and fitness to hold a position as a commissioned officer.

According to the circular issued by the War Department prior to the examination a year ago, an average of at least 80% must be obtained by the candidate on the examination or he will be marked as failing. He will also fail if he does not receive a mark of 67% in any of the subjects listed. The probational appointment as second lieutenant is for one year only. At the end of the year a final examination is required on a dozen subjects of military engineering, including the candidate's military record and aptitude as certified to by the company, post and battalion commanders under which he has been. Candidates are required to obtain a mark of at least 75% in each subject included in this last examination.

As some of the readers of *Engineering News* may be interested in seeing what sort of questions are asked in the examination for a probational appointment, the examination questions used a year ago in the subject of theoretical and applied mechanics are given here:

THEORETICAL AND APPLIED MECHANICS

Part 1 (time, 3 hours).

I. Value, 7. 3 (a) Define stress; elastic limit; modulus of elasticity.

4 (b) A steel wire whose cross-sectional area is 0.01 sq.in. is to support a weight of 200 lb. as a pendulum. It has upon it two marks which are 200 ft. apart. What is the distance between the marks after the weight is added, the modulus of elasticity of the wire material being 30,000,000?

II. Value, 8. A flywheel whose mean diameter is 24 ft. is built up of four equal segments which are bolted together with two bolts at each joint. The rim is 4 in. thick and 18 in. wide and the material weighs 490 lb. per cu.ft. The wheel is designed for a normal speed of 75 r.p.m., and as a factor of safety the influence of the spokes was disregarded in designing the bolts. The safe stress on the bolts was assumed as 14,000 lb. per sq.in. What is the diameter of the bolts?

III. Value, 11. 6 (a) The coefficient of expansion for steel is 0.0000030; that for brass is 0.0000065. A steel column whose cross-sectional area is 5 sq.in. is 50 ft. long and is surmounted by a rigid crosspiece from the bottom side of each end of which hangs a brass rod whose cross-sectional area is 2 sq.in. Compute the length of the rods so that, regardless of temperature changes, their lower ends shall remain at the same elevation.

5 (b) If the rods are assumed to be 35 ft. long and have their lower ends immovably fixed, what total stress will be induced in the anchorage by a fall in temperature of 150°? Modulus of elasticity of brass is 10,000,000.

IV. Value, 13. 7 (a) Given the following beam without weight: Starting from the left-hand side there is a cantilever 5 ft. long to the support A. This cantilever is loaded uniformly with 1 ton per foot of length. From the support A to the support B the distance is 20 ft. Beyond B there is another cantilever 9 ft. long loaded with a concentrated load of 2 tons at its outer end.

Determine the amount and position of a concentrated load such that the beam may be cut through beneath it without disturbing the equilibrium of the system.

6 (b) Construct the shear and moment diagrams of the above beam with the unknown load added. Shear scale, ¼ in. per ton; bending-moment scale, ⅛ in. per ton-foot.

V. Value 11. 6 (a) A bar of steel whose modulus of elasticity is 30,000,000 is placed in a testing machine and subjected to tension. The cross-sectional area of the bar is 4 sq.in., its length is 20 ft., and its elastic limit of 60,000 lb. per sq.in. is reached in 15 seconds. What horsepower must be supplied the driving motor, assuming its efficiency to be 85% and that there is 10% loss of power in the testing machine?

5 (b) If the machine is provided with suitable reducing gears and with an automatic clutch designed to slip when the pull on the motor pinion (2 in. in pitch diameter) exceeds 40 lb., what must be the least speed of the motor at its maximum delivery during the above test?

Part 2 (time, 3 hours).

VI. Value, 10. 3 (a) In making compression tests of cast-iron columns 15 ft. long and 48 sq.in. in cross-sectional area the elastic limit of the material was reached at a unit pressure of 15,000 lb. per sq.in., the material having a modulus of elasticity of 15,000,000. Determine the resilience of the columns.

3 (b) Determine the modulus of resilience of the material.

4 (c) What load falling from a height of 4 ft. above the column will also strain the column to its elastic limit?

VII. Value, 7. A shaft in two parts is coupled with a coupling having in it 8 bolts, the bolt circle diameter being 18 in. The shaft transmits 1000 hp. at 500 r.p.m. If the safe load on the bolt material is 6000 lb. per sq.in., what is the diameter of the bolts?

VIII. Value, 8. 4 (a) Find the thickness of a spherical shell 6 ft. in diameter which is used as a receiver for compressed air at a pressure of 240 lb. per sq.in. above the atmosphere, the allowable unit stress of the material being 8000 lb. per sq.in.

4 (b) How great may be the diameter of the copper delivery pipe whose walls are $\frac{1}{4}$ in. thick and whose safe load is 3000 lb. per sq.in.?

IX. Value, 13. 5 (a) An open caisson 50 ft. long and 10 ft. wide (inside dimensions) has been sunk in still water which has risen to a height of 36 ft. above the bottom of the caisson. The sides and ends simply rest on the bottom and the sides are supported by the ends. The ends are protected against collapse by longitudinal braces. Two cross-members are placed across the ends with their centers at heights of 5 ft. and 24 ft., respectively, above the bottom. Against these butt the longitudinals, being centered vertically on the cross-members, but horizontally their centers are 1 ft. in from the sides; they are 8 in. by 8 in. in cross-section, and there are four of these longitudinals in all. Neglecting friction, what is the unit pressure on the ends of the longitudinals?

4 (b) The pier within the caisson weighs 165 lb. per cu.ft. and is 45 ft. long and 5 ft. wide, and at the present stage of water it just prevents movement of the caisson. The caisson itself is neutral as to buoyancy. How high is the pier?

4 (c) As a matter of safety the caisson is allowed to flood to a depth of 25 ft. At what stage of the water will the previous condition of instability obtain?

X. Value, 12. 6 (a) A dam having a vertical face on the reservoir side is 175 ft. high and the water behind it stands at 160 ft. At a depth of 150 ft. below the crest is the top of the rectangular opening delivering water to the penstock supplying a turbine. The opening is 4 ft. wide and 8 ft. high and is closed by a sliding valve, the valve being operated by a vertical rod from above. The penstock has a cross-sectional area equal to that of the opening, and the water flowing through it supplies a turbine which is direct-connected to an electric generator; the efficiency of the turbine is 75% and that of the generator is 92%. What must be the size of the valve rod when safely loaded to 16,000 lb. per sq.in., the coefficient of friction of the gate under pressure being 0.3?

6 (b) If the velocity of flow in the pipe is 47 ft. per second, what kilowatt energy is being delivered by the generator?

Breadth vs. Specialization in Engineering Study

The ruin of a vessel within three months of its launching described elsewhere in this issue, may serve a useful purpose in calling attention to the value to an engineer of information on a wide range of engineering work. Nothing is more common than to hear engineers and especially young engineers declare that they have no interest in engineering literature outside their own field of work. That contains, they say, all that they can possibly find time to read about. They propose to keep up to date in that and to let the rest go.

Such narrow specialization as this is responsible for many failures in engineering work. A man accustomed to civil-engineering work, for example, finds it necessary to design a special machine for use upon some work, and because of his limited knowledge of mechanical engineering he does not make sufficient provision for lubrication.

The hull of the "Sea Call" was ruined because the steel surfaces exposed under water formed a galvanic couple with the monel-metal plating of the hull and the corrosion of the steel naturally followed. Previous examples of such corrosion from galvanic action of dissimilar metals immersed in sea water are on record in engineering literature. Less than a dozen miles away from the yard where the "Sea Call" was built is the Charles River Dam. Before that dam was built a series of experiments was made, to determine whether galvanic corrosion would result from the use of manganese-bronze truck axles on the steel gates. As a result of these experiments, zinc plates were attached to the bronze axles to protect the steel from corrosion. The use of zinc plates on naval vessels that have steel hulls and manganese-bronze propellers is well-known. The fact that nickel and iron form an active galvanic battery when immersed in a corrosive solution is illustrated by the well-known Edison storage battery.

Attention is called to these matters simply to impress upon engineers, and especially upon younger readers, the value of broad knowledge as well as specialized knowledge. It has been often remarked that many important inventions have been made by men who were unfamiliar with the technical details of the industry to which their invention applied. Their experience in other fields of work, however, enabled them to bring to the problem a range of knowledge that too often is not possessed by the specialist in the industry.

Orderly City Development

The zone, or district, system of controlling the character and use of buildings is an essential feature of modern city planning and replanning. The system is common abroad, but has scarcely gained a foothold here. It cannot make much progress in the United States without the general adoption of constitutional amendments. Such an amendment was before the New York Constitutional Convention. It read:

> The Legislature may delegate to municipalities the right to create, fix and regulate areas or districts for private residences, for the location of trades and industries, and for the protection or improvement of particular localities, and to limit and regulate the height, dimensions, kinds and uses of buildings, by districts or otherwise.

It was to be hoped that this, or some equally adequate means to the same desirable end, should have been adopted by the convention at Albany, to be approved by the voters in November and put into effect by the Legislature of 1916. Haphazard city growth is for the temporary benefit of a few property owners. Well-ordered city growth benefits all the people for all time.

Big Steamships and Economic Ocean Transportation

A dozen years or more ago there was a great deal of discussion as to the rapid increase in the size of ships and its influence on economic freight carriage at sea. About that time James J. Hill, President of the Great Northern R.R., gave a contract for the construction of two of the largest vessels ever built for freight carrying to run in Transpacific service in connection with that railroad. The end of that experiment has just been announced. One of those two huge vessels, the "Dakota," was stranded after she was put into service, and became a wreck before she could be hauled off. The other big vessel, the "Minnesota," after experiencing various vicissitudes, was continued in service and only recently was said to have transported across the Pacific the largest cargo of freight ever transported by a single ocean vessel. Notwithstanding this and the high rates for ocean freight now prevailing, it has been recently announced that the railway company has decided to retire her from service and offer her for sale.

While it is quite possible that the impending changes in the United States navigation laws may have something

to do with this decision, it is also stated that the vessel has not proved the profitable carrier that was expected. As has been frequently pointed out in these columns, the experienced ship owners of Great Britain and Germany, who doubtless understand the ocean-transportation business better than the business men of any other nation, continue to build freight vessels of moderate size in order to earn profits. It is only on the route between New York and Europe, where high-class passenger traffic is under competition, that vessels larger than 20,000 tons have ever been put in profitable service, and very few ships operated on any other route exceed 10,000 tons.

Public-Health Instruction at Ohio State University

The establishment of a department of public health and sanitation at Ohio State University is significant both in aim and in the method proposed to accomplsh the aim. The University announcement states:

> The principal object of this course is to prepare young men and women for public-health work in Ohio and elsewhere and to fit them to occupy administrative and executive positions as health officers or members of boards of health or secretaries, agents or inspectors of health organizations. It is planned to provide the scientific groundwork of sanitary knowledge which underlies efficient health administration.

The degree of master of science in public health will be given after one year's study, but candidates must hold the degree of doctor of medicine or of bachelor of arts or its equivalent, and candidates with the master's degree must have had a year of preliminary collegiate training in chemistry, physics, zoölogy, comparative anatomy and pathogenic bacteriology. Most of the courses offered will be given in the Graduate School of the University. A number of the instructors appointed are members of the staff of the Ohio State Board of Health. The instructor in public health engineering is the chief engineer of that board.

The whole plan is commendable because, on the basis of either one of the required preliminary degrees mentioned, it offers specific training in the fundamental knowledge required by the modern public-health officer without adding a long course of study to that already pursued. The idea is not to turn out sanitary engineers, chemists, bacteriologists or pathologists, but rather, administrative health officers, competent to direct these and other employees of a health department. For those who wish to specialize, however, facilities are offered.

Good Bridge Paint

In 1878 a wrought-iron highway bridge was built over the Little Wabash River at Carmi, Ill., and the bridge stood until a few months ago, 37 years in all. Describing how a flood washout wrecked the bridge, G. H. Brown, the county superintendent of highways, closes his account[1] with the following laconic statement: "The iron in this structure was treated with a good coat of paint when it was erected and had another about twenty years ago."

Here is a remarkable record of paint endurance: A coat of paint lasted about twenty years. This is not a single result, but twice in succession the same experience was had—the second coat seems to have endured at least as well as the first. In view of the fact that a life of ten years is considered very good for bridge paint (the eight-year endurance of the paints in the Havre de Grace test was considered highly creditable), there ought to be no doubt that the performance of the Carmi paint is phenomenal.

A point of doubt remains, however. The first coat of paint, we know, had an ultimate life of about 17 years, but we do not know the ultimate life of the second coat. Mr. Brown does not say that it was gone. Had the bridge not been washed out, perhaps the paint would have lasted many more years—ten, or possibly even another twenty. Though the record made is so excellent, yet it may be that the flood deprived us of an even more notable record.

The work on the Brooklyn-Brighton viaduct in Cleveland (see the first page of this issue) is a typical illustration of the present high state of the art in concrete construction. Strictly speaking it is rather better than typical or average, for it has proceeded with exceptional smoothness and freedom from interruptions or complicating occurrences. It was unusually rapid and systematic. But with all due credit to the Bates & Rogers work, it can still be taken as a fair illustration of the fact that fast work in concreting is now the regular thing. We refer to a speed which not many years ago would have been out of the question. In the present case, we must remember, two bridges of 1,700 ft. are built successively, in a single season, or a total of 3,400 ft. of arch viaduct. That this is regarded as a practical or regular rate of working is indicated by the fact that at Harrisburg, Penn., the Grace contract for the Susquehanna bridge of the Cumberland Valley R.R. calls for the construction of 4,000 ft. of arch viaduct in a season.

In *Engineering News* of July 1 comment was made on an advertising leaflet issued by the University of Pittsburgh, in which a statement was made as to the average compensation of engineering graduates of twenty years' experience. Since this publication we have been informed by authorities of the University that the leaflet in question was prepared some four years ago. The figures used in its preparation were obtained from the publication of another institution and were at that time deemed to be reliable, and the statements made in the circular as to the demand from employers for graduates from the engineering course corresponded to the conditions prevailing at that time.

A number of copies of the circular were distributed through the mails at that time, in answer to requests for information, but none have been distributed since then so far as the University authorities were aware, and the recent appearance of one of the circulars, which were supposed to have been destroyed, they are at present unable to explain. Official representatives of the trustees and faculty of the University have expressed to us most emphatically their agreement with the position that misleading advertisements should not be published by any organization, least of all by an institution of learning, and assure us that the recent appearance of this circular was not authorized by the University authorities. We are glad to make this statement in justice to the University and its School of Engineering.

[1] In "Illinois Highways," the bulletin of the State Highway Department.

Letters to the Editor

The "Eastland" Disaster and Vessel Stability

Sir—The capsizing of the steamer "Eastland" in the Chicago River on July 24 has opened for discussion a technical subject about which people in general know less than nothing and about which the average engineer, unfortunately, knows but little more.

It seems to be generally supposed that a floating body rolls about its center of buoyancy, and that if the center of gravity of the body rise above the center of buoyancy,

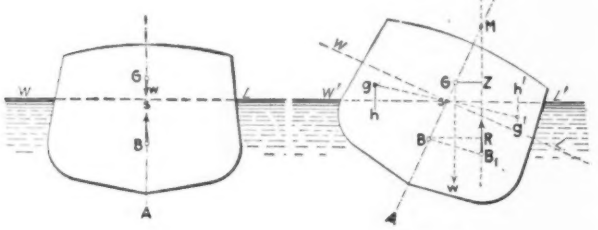


Fig. 1

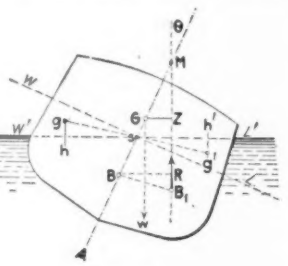


Fig. 2

the body would capsize. In *Engineering News* of July 29, 1915, you state that it is an elementary principle of vessel construction that the center of gravity of the vessel as a whole must be lower than the center of buoyancy in order that the vessel may remain upright. This statement is misleading, as that condition rarely if ever exists in ships. Such a condition would produce a ship so stiff that it would be very uncomfortable to ride on and would be easily swamped in a beam sea. In fact, about the only vessel approaching this condition is the fast sailing yacht.

A floating body does not roll about its center of buoyancy nor its center of gravity. It rolls about a center known to the marine engineer as a metacenter, which is located on the axis of the ship's section at the intersection of the vertical through the center of buoyancy in an inclined position.

Referring to the accompanying sketches, Fig. 1 represents a section through a ship floating at a water line indicated by WL. The center of gravity of the ship is located at the point marked G, through which the weight of the ship W acts downward. The center of buoyant forces is at B. To satisfy conditions of equilibrium the buoyant forces must equal W and act vertically through B and G. The ship is thus in a state of rest.

Now if we consider this condition of rest to be disturbed and the ship heels over to an angle, then the condition of equilibrium no longer exists. Referring to Fig. 2, we find a new water line indicated by $W'L'$. We have taken away from the left side a buoyant wedge WSW' and added it to the right side. Indicating the volume of this wedge by v, its center of gravity by G, the total displacement of the ship by V, and the horizontal shift of the center of gravity G by hh', then the horizontal shift of the center of buoyancy from B to R would equal the volume of the wedge multiplied by the distance hh' and divided by the total displacement V; that is $BR = \frac{v \times hh'}{V}$.

The new position of the center of buoyancy is on a vertical line through R and located from B parallel to gg'. Extend the vertical through R and it will intersect the axis AS at the point M, which is the metacenter, or the center about which this ship will heel.

It will be observed that the buoyant forces acting through B no longer act through the center of gravity G and the state of equilibrium has been destroyed. The buoyant forces act to the right of G a distance indicated by GZ, known as the righting arm or lever arm, the length of which is

$$\frac{v \times hh'}{V} - BG \sin \theta$$

hence the moment of stability

$$= GZ \times W$$

$$= W\left(\frac{v \times hh'}{V} - BG \sin \theta\right)$$

It will be observed that if M is above G, a positive lever arm exists and the action of the buoyant forces is toward righting the vessel; but if G is raised to a point above M, then a negative level arm exists and the vessel will capsize.

If the stability moments are calculated for various values of θ and for various conditions of loading, curves

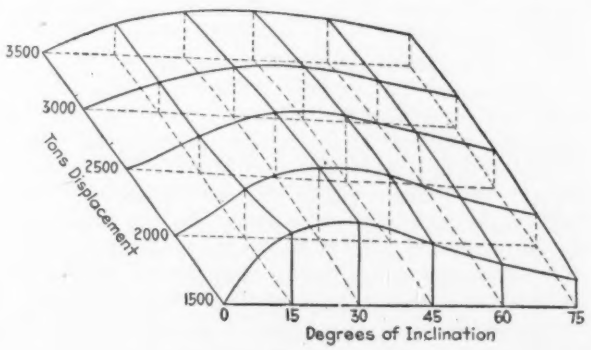


Fig. 3

may be made which will absolutely tell the story of any particular hull, such as are shown in Fig. 3.

Unfortunately the calculations involved in determining the statical stability of a ship are long and tedious and are rarely made. If the United States Government had required a complete set of such curves to be on file before the issuance of inspection papers, it is my belief that the "Eastland" would never have been placed in the excursion trade.

This ship was built for the fruit trade across Lake Michigan and for this purpose she was well fitted, her cargo being light and carried low and her speed high, as is required for the transportation of perishable cargoes.

The United States Government should not permit the reconstruction of any vessel without requiring a new set of stability calculations to be made and filed before issuing new inspection papers.

The "Eastland" was reconstructed for service that she was not fitted for at all. She was reconstructed for excursion service; some of her upper works were removed to make room for dancing. Such a cargo is necessarily carried higher, thus raising the center of gravity. This condition may be met by using water ballast, which is generally accomplished by constructing an inner bottom, the space between this and the outer shell being divided into compartments which may be filled with water. The "Eastland" was built this way. If all these compartments are only partly filled with water at the same time, then a condition of "free water in the hold" exists, and in this condition the center of buoyancy does not shift as far as it would if the compartments were full or empty. If under these conditions *B*, Fig. 2, should fall to the left of a vertical line through *G*, then a condition of negative stability would exist and the ship would capsize.

It has been suggested that the cause of the "Eastland" disaster was due to the ship being constructed without a keel. Keels do not prevent ships from capsizing. In single-bottom vessels they are used for structural purposes and in double-bottom vessels they do not exist except in the form of keelsons, which act to make the ship roll with the sea, thus making them more comfortable for passengers.

Too much emphasis cannot be placed upon the statement in your issue of July 29 that the primary cause of the "Eastland" disaster must be sought in the condition of her water-ballast tanks.

REGINALD A. TOWLER.

33 Casgrain Ave., Detroit, Mich., Aug. 2, 1915.

Mortar Beds; Brick and Granite Block Pavements

Sir—In the editorial in *Engineering News* of Aug. 5, 1915, on "Mortar Beds for Brick and Stone Pavements," you speak of the resiliency of sand cushions. Granting that a sand cushion has some resiliency, the beneficial effects, if there are any, of this resiliency are nullified by its variability and by other factors incident to proper block-pavement construction. The variability is caused by natural variation in moisture content of sand, variation in depth of cushion, in grading of sand, in depth of blocks, and in amount of compression by roller or rammer. The wedging effect of the blocks, the binding of the grout, and the crowning action of the pavement also affect the resiliency.

The fact of the matter is that no two spots on a well-constructed sand-cushion brick pavement seem to have the same degree of resiliency. The deflection of various pavements in Kansas City under a wagon-wheel load of 1500 lb. was measured by James E. Howard, formerly of the United States Bureau of Standards, with a delicate level spanning 12 in. Briefly, it was found that one-course plain concrete pavement 6 in. thick deflected 0.0002 to 0.0006 in. when tested as noted. Cement-grouted brick pavements on a 6-in. concrete foundation deflected from 0.0003 to 0.01 in., and stone blocks from 0.0003 to 0.0019 in. These limits were determined by a large number of trials in each case on a number of pavements of different ages in various parts of the city and are exclusive of trials made near manholes, cracks, expansion joints, etc. The older sand-filled brick pavements showed a much greater variation.

The point I wish to bring out is that while concrete pavement showed a very uniform deflection, the brick varied from a deflection that would indicate a support as rigid as the concrete foundation it rested on to one suspiciously like what might be expected from brick depending for support entirely on arch or wedge action.

Without repeating the many arguments for or against the plain sand cushion, it seems to me that with a properly built brick or stone pavement the term cushion is a misnomer. It is rather the *sand bed* which levels up inequalities in the base, allows slightly misshapen brick to be rolled down to a smooth surface and beds each brick uniformly. The sand bed for block pavements has performed its function with credit to itself, but engineers are beginning to recognize that its vagaries are detrimental to the pavement that must stand the severity of traffic in the present-day large city. A more perfect bedding material is obtained when cement enough to hold the sand grains in the bedding course is used. This may be placed in the same manner as the sand cushion and the blocks rolled or rammed into it before the water is added to set the cement. Such a construction will insure the maintaining of a uniform bearing for the wearing surface.

City pavements must be so constructed, in order to withstand modern traffic, that they will retain a smooth, even surface and wear uniformly. Traffic soon searches out any variation or weakness in structure. The sand-cement bedding course is an improvement over the plain sand cushion, and maintains the blocks to uniform grade with less variation. The sand-cement mixture is as resilient as the portions of a plain sand cushion that have been properly compressed and that properly bed the blocks.

CLARK R. MANDIGO,
Assistant City Engineer.

Kansas City, Mo., Aug. 28, 1915.

Sir—The editorial comment in *Engineering News* of Aug. 5 in regard to the substitution of mortar beds for sand cushions in constructing stone-block pavements expresses very fully and clearly my opinion on this subject, to which I have had occasion to refer in previous contributions on city pavements.

It is my belief, based both on experience in construction and on a study of the settled practice in the most important of the world's cities, that the modern street pavement is most successful when consisting of two elements—a solid, rigid foundation and a more or less elastic renewable wearing surface.

For the foundation, concrete is now almost universal. The wearing surface is usually one of two classes, composed either of solid rectangular blocks laid in close contact, or of a layer of mineral aggregate filled with bituminous cement.

In asphalt pavements, elasticity is provided for by an asphaltic-cement binder, and the wearing surface is laid directly on the foundation. Where there is some inherent elasticity in the blocks as in the case of wood, the pavement surface has been most successfully constructed when laid in close contact with the foundation.

That there must be some similar provision for elasticity in the case of stone-block pavements was recognized not only in Paris (as shown by your quotation) over 40 years ago, but also, to take a single other instance, in the city of Liverpool, where the first of its modern stone-block pavements was laid about 40 years ago. The method used then has been followed very closely ever since. The practice of other foreign cities, such as Hamburg, can also be cited to substantiate the statement that the general principles for successful stone-block pavements were worked out very nearly half a century ago, and that there remains very little scope within which the exploiter of new specifications can exercise his ingenuity.

In many years' experience with brick and granite-block pavements I have known of but one case where surface settlement was caused by running of the sand cushion. This was at Panama, after the fire department in an excess of zeal had spent one Sunday morning trying out the new fire hydrants, unfortunately selecting for this experiment a street in the process of paving. The result was that much of the new sand cushion found its way into the equally new sewer.

Laying granite blocks directly on a rigid foundation will not prevent such pavement depressions as are found in some of our granite-block streets, where investigation always shows an equal depression in the foundation. I know of no granite-block pavement in this country carrying denser or heavier traffic than Lafayette St., New York City, yet the condition of its surface today shows nothing upon which to base criticism of the fact that it was laid on a sand cushion.

The almost perfect surface of the stone pavements of Hamburg and the very uniform condition of those of Liverpool show success over comparatively long periods of time of the generally accepted method of stone-block pavement construction. Where the rigid foundation method has been adopted, as in the Borough of St. Pancras, London, and on certain streets in Birmingham, the method has been followed to its logical conclusion by filling the joints with cement grout, making in effect a monolithic pavement subject to the disadvantages of that type for city street surfaces. An attempt to combine the two methods by using a rigid base and an elastic joint filler would seem to give none of the advantages of either method.

One great fault of our paving construction as compared with that abroad is our tendency to spend more time on specifications than on inspection and results. In great cities abroad, specifications have only minor changes from year to year. In this country it is the ambition of each administration to adopt specifications differing from those of its predecessor, resulting in much literature but no improvement in actual conditions. Greater improvement could be obtained in our city streets by careful attention to the inspection of construction and subsequent maintenance than by any variation of the many excellent specifications which have been successfully tried out in the past dozen years.

HENRY WELLES DURHAM,
Consulting Engineer.

New York City, Aug. 20, 1915.

Sir—In connection with the Committee on Specifications under the Board of Public Service of St. Louis, I have made some study of the conditions and character of failure of vitrified brick pavements. I have also just had an opportunity of making observations on brick pavements in a number of Eastern cities and of comparing notes with other engineers, and recently I made an inspection of the brick laid on the green concrete foundation in Paris, Ill.

In the editorial on the use of mortar beds for brick and granite-block pavements, in *Engineering News* of Aug. 5, 1915, it is claimed that the sand cushion has been retained because it gives to the pavement surface a certain amount of resiliency. Now it has always seemed to me that in grouted brick and granite-block pavements this is exactly what it is impossible for the sand to do. A grouted-brick pavement is a good pavement only so long as the grouted joints are intact. If the whole paving surface acts as a sheet, it is impossible to see how the individual blocks can receive any resilient aid from the sand bed. After the grouted joints have been broken, and I believe this usually is caused by defective support from the sand cushion, the resilient action may come into play, but at the same time the pavement is practically ruined.

A close study of the vitrified-brick pavements in St. Louis has led to the conclusion that the initial failure of the pavement was caused by the varying percentages of moisture in the sand cushion as laid, resulting, on drying out, in a condition where the wearing surface is supported only at intervals. The pavement in the unsupported sections apparently breaks down, fracturing the grouted joints. The opening of the grouted joints naturally permits water to get into the sand cushion, and with the sand fairly saturated it is quite possible to imagine that the pounding of heavy loads causes a shifting of the bed, resulting in high and low spots. Every evidence of this type of failure has been found in St. Louis pavements, and the writer has observed identical conditions in Eastern cities.

From interviews with paving engineers of other cities, it is further believed that some appreciation of the action described has been the reason for the gradual reduction in many communities of the depth of sand cushion used.

During the past winter, a committee of engineers recommended, and the Board of Public Service of St. Louis adopted, a type of construction which eliminates the sand cushion entirely. Two kinds of cushions are now being tried. In one of these, limestone screenings are substituted for the sand. This material is subject to ready compacting and has high internal friction. Its use will certainly result in the improvement of brick pavements.

In the second type of construction, a 1-in. bed of 1:4 mortar is substituted for the sand cushion, and we have every reason to believe that this will entirely cure the troubles enumerated. This latter type, or something nearer the Paris, Ill., method of construction, will be used exclusively in St. Louis next year.

After visiting the work in Baltimore, Md., referred to in *Engineering News* of Aug. 5, 1915, p. 276, and inspecting actual construction, I am more convinced than ever that the mortar-bed type of construction is a long step toward the realization of efficient brick pavements. The construction of brick pavements as exemplified in Baltimore and St. Louis is simpler, and if anything involves fewer contingencies than the old class of work with the sand beds. While the ultimate results are still a matter of speculation, it seems reasonable to believe that this construction will add ten years or more to the life of brick pavements.

The laying of the brick on the green concrete foundation as exemplified in Paris, Ill., appeals to me as an ideal pavement. I was very much impressed with the smooth surface obtained by the use of a hand-roller, with the efficiency of construction, the cheapness of the pavement, and with the solid monolithic character of the finished work. If this pavement is undisturbed, its life would seem to be limited only by the wearing qualities of the brick. In large cities, however, there is one objection to this construction; that is the great difficulty in satisfactorily repairing cuts in the pavement. If this can be worked out, the Paris type of pavement is ideal.

This method of construction will also remove to a very great extent the objection to brick pavements on account of noise; for it is clearly demonstrated in the Paris pavements that, although there is a rumble from steel tires passing over brick laid on a sand cushion, there is only a slight rattle from the same vehicle on the new monolithic work.

W. W. HORNER,
Engineer in Charge of Design
of Sewerage and Paving.

St. Louis, Mo., Aug. 18, 1915.

Should Ferry Service Be Free?

Sir—In *Engineering News* of Aug. 5, 1915, Gen. H. M. Chittenden says:

> The freedom of the public highway is a freedom of use. If anyone wishes to walk or drive along it or transport goods, the public makes no charge. But the public does not undertake to transport him or his goods, except in special cases, one of which is the ferry. . . . [On the ferry] it carries the passenger and goods. The user is thus saved the expenditure of physical energy of himself and animals, wear and tear of equipment, expenditure of fuel oil, etc., in motor conveyance, over the route of the ferry. For this service, which is entirely special and in addition to that afforded by a bridge, it is right that the user should pay. He is simply paying for a service which, in the case of a bridge, he performs himself.

I submit that the distinction here set up between the road and the bridge (on the one hand) and the ferry (on the other) is wholly artificial and inconsequential and quite inadequate to justify any difference of practice as to tolls.

By building the road or the bridge or the ferry, the public spares to the user a far greater "expenditure of physical energy of himself and animals, wear and tear of equipment," etc., than by merely moving him and his goods over a small part of the line. When we have swallowed the camel by constructing the line, why strain at the gnat of merely moving persons and chattels over an insignificant portion of it?

Gen. Chittenden finds also that "ferries are special and exceptional facilities, affecting, as a rule, only limited portions of the community," and that "to make them free would thus be taxing a whole community for a special benefit to a limited portion."

But the users of the ferry (like the users of a bridge—also "a special and exceptional facility") are 100 per cent. of the users of the entire line. And probably there are members of the community who seldom or never use any part of the particular highway in question. By the same token, it would be unfair to tax these members for the benefit of those who use the highway extensively, or to tax the bachelor for the maintenance of public schools; but the bachelor (permitted to reside in a community uplifted by a public-school system) receives (cannot help receiving) in return for his taxes a value infinitely transcending the mere cost of tuition of a family of children; and since each of us is really a public servant, it is to the public's interest to facilitate our operations.

JOHN C. TRAUTWINE, JR.

257 S. 4th St., Philadelphia, Aug. 20, 1915.

Military Engineer Reservists

Sir—It is probable that every engineer is anxious to render himself serviceable to his country in assuring her integrity and safety, but this same engineer, with his deep-seated sense of economy and efficiency, cannot bring himself to see the immediate necessity of giving up an appreciable portion of his time at the most efficient period of his life to join a reserve corps and learn how to be an engineer from the viewpoint of an army officer. Or, to put it in another form, he fails to see why he is not as good an engineer without a military training as he would be were he imbued with the more or less deplorable spirit of the military caste.

Why not let the Secretary of War organize a civilian board of engineers who, acting in conjunction with the army engineers, can work out and codify the problems to be met and their solutions? The results of these researches could be recorded in suitable handbooks and thus rendered available to every engineer. The problems under war conditions should not be so much greater than under peace that the fundamentals could not be mastered in a similar manner to the standardized problems of any engineering work. With this manual available, any engineer who has had a reasonable amount of practical experience could easily master the standardized details and become a "military engineer reservist" without any trouble. Then let him signify to the proper authority his willingness to dedicate his service to the cause of his country if needed, have his name recorded with the usual formalities, and he becomes available without further trouble or expense in case of war. In this way each reservist engineer could become a nucleus about which could be gathered unlimited assistants in emergencies, and the country would have a reserve engineer corps of unparalleled magnitude.

The idea is presented for consideration with the hope that it may lead to some result that will render available to the country the brains of the combined engineering profession without the economic waste of actual military service during times of peace.

HERBERT D. MENDENHALL,
Consulting Engineer.

Jacksonville, Fla., Aug. 14, 1915.

NOTES AND QUERIES

The Paddle Wheel as a Pump is the subject of inquiry by an engineer in Fresno, Calif. He asks whether any engineer in the United States has ever constructed and utilized for raising water a scoop wheel of the type extensively used in Holland and illustrated in "Engineering News" of May 19, 1910, p. 582.

Cleaning Machines are the subject of an inquiry just received from the chief engineer of a Western railway. A machine is wanted which can be used to clean dirt, rubbish, etc., from stone-ballasted track as well as from track at stations where the ties are embedded in concrete. It is thought that some manufacturer may possibly have developed a vacuum cleaner for this special work.

New Toledo Coal Dock Built in Record Time

At the opening of navigation on the Great Lakes this spring, the Cincinnati, Hamilton & Dayton Ry. surprised its patrons with a new coal-handling plant, dock and yard at Toledo, the road's principal port on Lake Erie. While transportation was closed the old facilities in the Rossford district on the Maumee River were replaced. There is here now one of the three largest car dumpers in the country.

Yards and Dock

The work for the new coal terminal involved the construction of 802 ft. of concrete dock, concrete foundations for the unloader, approach and run-off trestles, the relaying of the load and empty yards, and the erection of the unloader frame and machinery. The new load yard has a capacity for 140 cars and the empty yard for 96 cars. South of the dock is a classification yard with a capacity for 3000 cars.

The dock, except at the unloaders, is of reinforced concrete on piles cut off 18 in. below the water line. The front line is of tongue-and-groove sheet piling. Tie rods run back from the concrete to inshore deadmen. The section at the unloader is of the same general construction except that a line of battered piles is omitted and the concrete is anchored to the machine-foundation slab.

Design of Car Dumper

Machines for picking up and dumping coal cars are ot new, but there are few the size of this one, which shows the latest practice. When the Pennsylvania, Norfolk & Western and Baltimore & Ohio roads, and other large coal shippers, proposed to increase the capacity of their cars from 50 and 75 tons to 90, it became necessary to increase the strength of the car dumpers. This machine and its two immediate predecessors were therefore built to lift a total load of 140 tons—leaving leeway to care for possible 100-ton cars with 10-per cent. overload. It is designed to dump 40 cars per hour; but up to 49 have been handled.

The cradle rail is 30 ft. above the lake level, which is higher than normally seen; this change is made to reduce to a minimum the amount of lift of cars in the machine.

The chief new feature on this machine is a disappearing mule for pushing the cars up to the dumper platform (Fig. 2). This necessitates a trough in the approach track deep enough to let the mule pass down under incoming railway cars, and a track on the bottom as well as the top. Formerly it was necessary to wait for the mule to get back into its pit before bringing in a fresh car; with this scheme cars are fed into the foot of the incline while the mule is coming down underneath them.

There are two switch gates operated by steam cylinders controlled by the reversing haulage engines so that when the engines are started hauling the mule is shifted to the upper track, and when the mule is lowered the gates on the incline are set to drop the mule upon the under track.

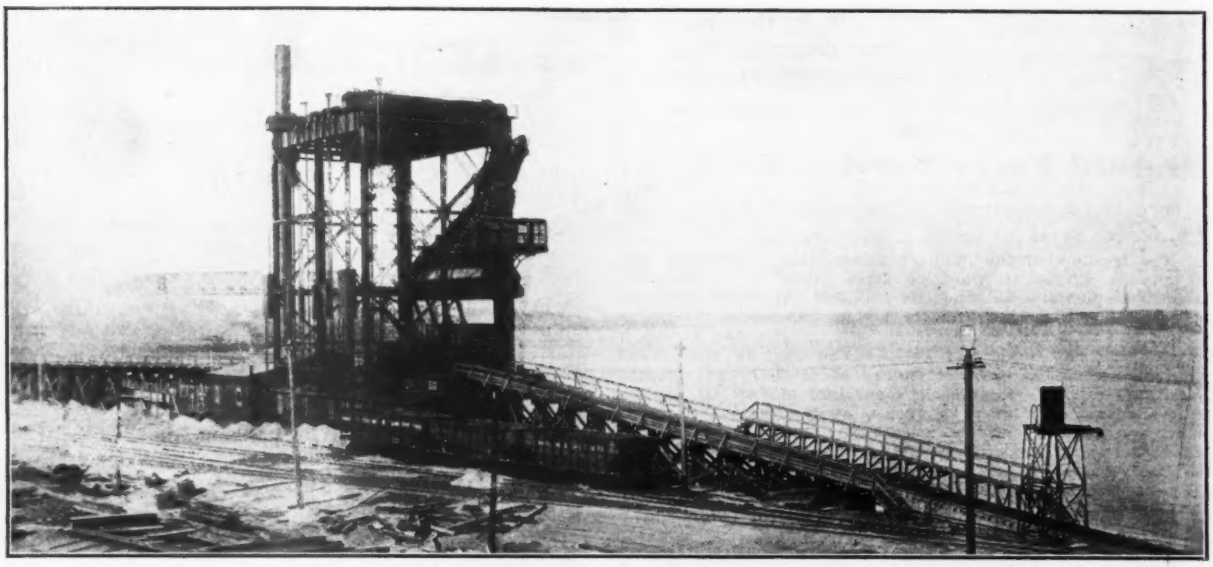


FIG. 1. THE TOLEDO COAL-CAR DUMPER OF THE CINCINNATI, HAMILTON & DAYTON RY.

To reduce the work required of the dumper boilers and engines, counterweights have been added to balance the dead-weight of the machine. There are two 50-ton boxes of iron punchings traveling up and down on the back of the dumper.

Large (22x24-in.) slow-speed engines are used on both haulage and tipple hoist. Two other engines serve the coal pan and distributing chute. Two 250-hp. internally fired Scotch marine boilers furnish steam. The machine has a revolving trimmer operated by an electric motor; otherwise all the motions are made by steam.

Operation of Dumper

The cars come down grade from a feed yard and go over the mule pit to the dumper incline, whereupon the mule rises out of the pit, comes up back of the car and pushes it up on the tipple. The platform and car are tilted sideways, the car being automatically gripped by four large clamps. The maximum inclination is 70 deg.

The coal is received on a pan which is lifted by screws to follow the car. The pan discharges into a chute and an operator on the pan directs the travel of coal to different parts of the boat. When the car is empty the cradle is returned to its original position and the upcoming loaded car pushes the empty off the platform and it runs down grade to the storage yard.

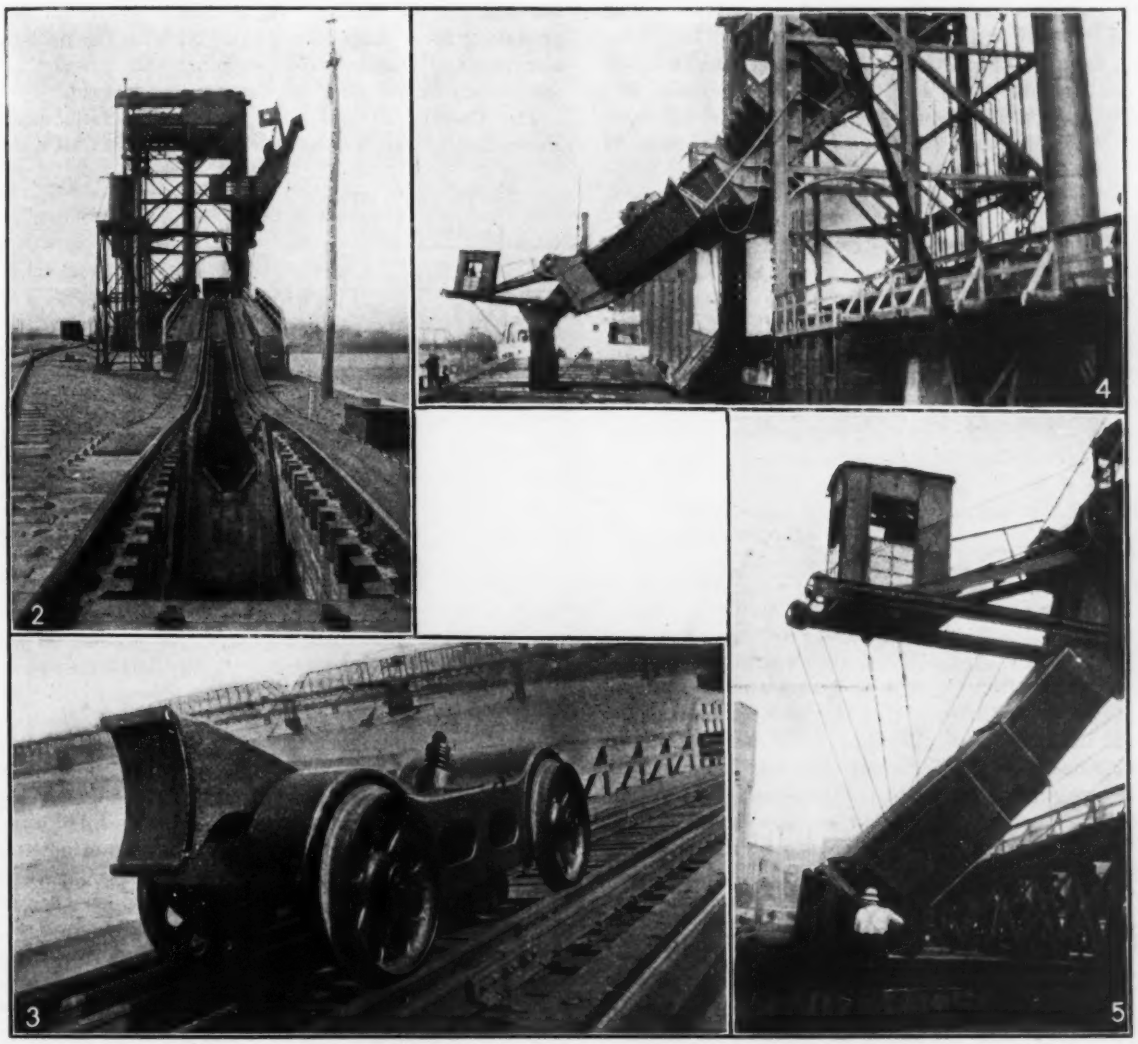
Construction and Erection

Contracts for the foundations and dock were let about Nov. 1, 1914, and preparations were rushed. The old plant was abandoned on Dec. 2 and work started the next day.

Piles in front of the old dock were driven by floating equipment, using steam hammers. Land drivers were used back of the old dock. A tug kept the river ice broken up and clear of the work. The unloader foundation was first laid and then the dock piles nearby were driven. The fill between docks was started and the pile driving pushed further along, then fill was made to the level of the concrete.

Stone and cement were brought in by rail, and sand by boat. The mixing plant was about 1000 ft. south of the car dumper and here was equipment for heating all the material. Concrete was hauled in bottom-dump buckets on narrow-gage flat cars. A boiler plant at the unloader foundations kept the concrete warm after placing, so that the weather never interrupted work. Some of the concrete was placed while the outside temperature was as low as 12 deg. below zero.

The machine foundations were completed Feb. 8, 1915. The mule-pit concrete was finished Mar. 7.



FIGS. 2 TO 5. DETAILS OF TOLEDO CAR DUMPER

Fig. 2—Mule pit and approach incline. Fig. 3—Mule. Fig. 4—Tilted car, pan and chute. Fig. 5—Chute discharging

The first structural member was set Feb 15, and the erectors worked for a time in two shifts—early morning to noon and noon to night. In 65 working hours the main frame was ready for the riveters, who worked in four gangs in the midst of erection of other structural material. By this time the machinery began to arrive, and its installation was started along with the piping work, sheeting, glazing, etc.

The rapid erection was largely due to the way in which the material was handled. The parts were made up from

the drawings of the Cleveland and Sandusky machines, which course saved time. A schedule was in force giving the time allowed for starting each part of the construction, the time for riveting, installing machinery parts, etc. There are about 400 tons of structural material in the dumper and 350 tons of machinery.

The reconstruction of the railroad yards started Dec. 6, 1914, and was completed April 12 when the machine was ready. The new elevation was about 9 ft. above the old and the filling material was waste cinder and slag hauled to the site in standard-gage cars.

The approach and run-off trestles were erected by the substructure contractor, the material being formed nearby and handled with a locomotive crane.

The design and construction of this terminal were under the direction of F. L. Stuart, Chief Engineer, B. & O. R.R., and the work was prosecuted under the supervision of A. M. Kinsman, Engineer of Construction, W. S. Bouton, Engineer of Bridges, A. H. Griffith, Assistant Engineer, and P. Callahan, Resident Engineer.

The Smith-McCormick Co., of Easton, Penn., were the contractors for substructures and trestles. The dumper was designed, built and erected by the Wellman-Seaver-Morgan Co., of Cleveland.

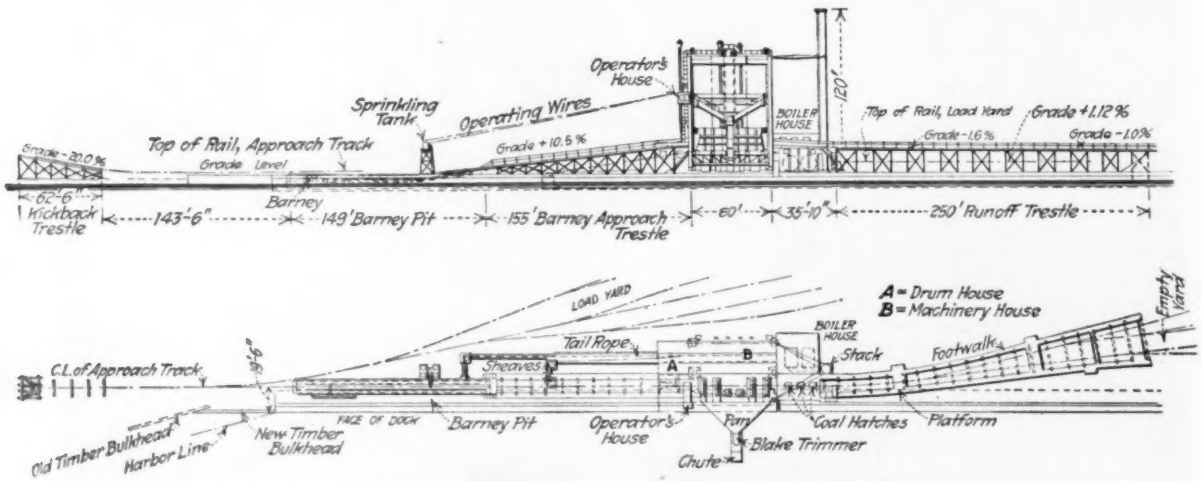


FIG. 6. PLAN AND ELEVATION OF NEW TOLEDO CAR DUMPER

Galvanic Corrosion Damages Hull of Yacht

A very large new sailing yacht, the "Sea Call," built for Alexander Smith Cochrane, of Yonkers, N. Y., at a cost said to have been in the neighborhood of half a million dollars, has been so injured by corrosion, within three months after her launching, that she has been dismantled and scrapped. The case is of especial interest to engineers, as it is one of the most remarkable instances on record of serious damage resulting from the galvanic action of dissimilar metals in a structure exposed to sea water.

The yacht was intended by its owner for ocean cruising. He desired to visit out-of-the-way corners of the world where no facilities exist for dry-docking or hauling vessels out of the water to remove marine growths from the hull. It was therefore decided to build the portion of the hull under water of monel-metal plates, using steel plates, however, above the water line. Monel metal is an alloy produced and marketed by the International Nickel Co. and named in honor of Ambrose Monell, its President. It is an alloy containing about 67% nickel and 27% copper. As might be expected from these chief constituents, the metal is highly resistant to corrosion. It has a strength about equal to that of mild steel.

According to the statement of the builders, it was the original intention of the vessel's designer, William Gardner, to use monel metal for the stem of the vessel, the rudder frame and the propeller frame, as well as for the under-water plating. Some difficulty was found in producing these parts in monel metal with the necessary accuracy and freedom from warping, and it was finally determined to use steel for these pieces instead.

The framing of the hull was of steel bulb angles. Monel-metal rivets were intended to be used in all monel-metal plates. In a very few cases, however, steel rivets were used by mistake in the monel-metal under-water plating. Attention was first attracted to the serious corrosion that was going on by the failure or total disappearance of one of these steel rivets. A stream of water entering through the open rivet hole was temporarily stopped by a pine plug and later by sending down a diver who put in a steel bolt as a permanent repair. In a very few weeks, however, this bolt was also eaten away. About this time it was decided to haul the yacht out of the water to remove the marine growths that had accumulated on the hull, for it was found, contrary to the expectation of the designers, that the salt water had so little effect on the monel-metal plates that the hull rapidly accumulated enough "grass" to check the vessel's progress. The serious corrosion which had taken place on the steel parts under water was discovered when the hull was exposed to view.

The most severe corrosion took place on the thin steel rib which forms the outer frame of the rudder (the rudder itself being covered with monel-metal plates). The reason why the corrosion was so severe here was very likely because of the rapid flow of water across the rudder edge, removing the corrosion as fast as it took place and thus presenting clean metal to the action of the elec-

tric current. A similar effect, almost as severe, took place on the steel stem of the vessel. Deep pits were eaten into the steel. There was heavy corrosion also on the steel propeller-frame casting and rudder shank.

The monel metal itself, as would be expected, showed not the slightest evidence of corrosion anywhere; and had the corrosion been confined to these outer steel pieces described, they could probably have been replaced at no serious expense by similar parts of monel metal and the galvanic action thus terminated. A more serious situation, however, was presented by the interior of the vessel. It was clearly evident, from the action on these exterior steel parts, that as the interior steel framing was connected to the monel-metal plates, corrosion would be inevitable there under the action of the bilge water. The probability that this might proceed unnoticed until the vessel's structure would be seriously weakened was doubtless the consideration that led to the decision to cut up for scrap a vessel which had been launched no longer ago than last March.

The "Sea Call" was 150 ft. long on the load water line, with a length over all of 214 ft., her bow having an enormous overhang. The beam of the vessel was 33 ft. 6 in. and the draft was 18 ft. The vessel had a heavy lead keel covered with monel plates and in addition a large centerboard. It was to be equipped with a 400-hp. internal-combustion engine as auxiliary power, but the engine was never installed.

The yacht was dismantled at the yards of her builders, Geo. Lawley & Sons, at Neponset, Mass. On Tuesday, Aug. 24, the hull was hauled out of the water on the marine railway at the Lawley yards, where it was inspected by one of the editors of *Engineering News*.

The possibility of galvanic corrosion occurring had evidently suggested itself to the designers of the vessel, for we are informed that experiments extending over several months were made at the Lawley yards on plates of monel metal and steel electrically connected and immersed in sea water. These experiments, we are informed, showed no appreciable corrosion of the steel and no measurable current in the wire connecting the plates, and it was therefore deemed safe to proceed with the construction of the "Sea Call" on the lines described. The present condition of the vessel, however, is indisputable evidence that the conditions in the boat itself were entirely different from those which existed in making the experiments referred to. It is doubtless true that the area of monel metal exposed to the sea water being very large in comparison with the area of steel exposed, the corrosion of the steel was concentrated.

It seems indeed strange that some such action should not have been foreseen in view of the large amount of experience on record as to the effect of galvanic action between steel and some of the copper alloys when immersed in sea water. Monel metal, we are informed, is almost identical with manganese bronze in its electrical relation to steel when connected as a galvanic couple. In ships which use manganese-bronze propellers it has become common practice to attach plates of zinc to the hull. As the zinc is more electro-positive than the steel, the corrosion due to the galvanic action with the manganese-bronze propeller is concentrated upon the zinc and the steel is protected.

Only a few miles distant from the Neponset shipyard is the Charles River dam. On the lock gates of this dam truck axles of manganese bronze were used. In *Engineering News* of Mar. 18, 1909, Edward C. Sherman described the extensive tests which were carried on to ascertain the amount of galvanic action that would take place on steel and manganese bronze joined electrically and immersed in sea water. As a result of these tests the steel portions of the dam were protected from corrosion by wrapping zinc sheets around the bronze axles.

Minneapolis Filter Patent-Case Decision

The Jewell water-filter patent-infringement suit (Ira H. Jewell vs. City of Minneapolis) was decided for the most part against the city early in August, 1915, by the United States District Court for Minnesota, Fourth Division. The original petition alleged infringement of three patents, but was narrowed before the case came to decision by striking out one patent entirely and some of the claims of the others.

The patent stricken out of consideration was No. 649,409. This was on the combination with a filter bed of a filtered water chamber beneath the bed, with columns supporting the bed from the bottom of the chamber and means for forcing the water up from the chamber through the bed.

Patent No. 649,410, on central control of filter operation, was finally contested on claims 1, 2, 6, 7, 8 and 9. Claim 1, which was the only one allowed, read as follows:

> A filter provided with a system of controlling valves which are provided with actuating devices located so as to be accessible for control from a single position of an operator.

The city contested this claim on the ground of anticipation, alleging that the use of power-operated in place of hand-operated valves did not constitute novelty and invention, but the judge, although admitting doubt, gave the benefit of the doubt to the plaintiff. The claims denied were on a whole filter system controlled "from a single position of an operator."

The third patent at issue, No. 649,411, was pressed only as regards claim 14, as follows:

> A filter comprising a tank having a tapered lower end and an opening at the bottom of the same, a screen at the lower end of the tank in line with said opening, a granular filter-bed within said tank, the part of said bed contained within the tapered portion of the tank being made of relatively large granules whereby water passing upwardly there-through in washing the filter is laterally deflected so as to be distributed throughout all parts of the bed and a screen interposed between said larger granules and the part of the bed above the same.

This claim the court sustained, regardless of the city's claims of anticipations by Hyatt and others. Although not asserting that Jewell invented high-velocity filter washing, the judge declared that the arrangement described in the claim made such washing "a practical and efficient process."

Engineering News is informed that the screens between the gravel and sand for holding the gravel in position during the washing operation were discarded in the 12 filters of the Minneapolis plant about a year ago and that neither screens nor substitutes therefor were used in the four new filters built since the beginning of the suit.

The city will appeal from the decision on both patents.

News of the Engineering World

Old Storm Sewer Bursts

A heavy rainfall at Baltimore, Md., on Aug. 12 surcharged and burst an old storm sewer in Patterson Park, flooding a swimming pool and adjacent land. The sewer was 7 ft. in diameter, with a two-ring brick arch, and with only 12 to 18 in. of cover where the fracture occurred. The arch split and lifted along the crown for 50 ft., then settled back in place without entirely collapsing. Had the cover been deeper it is believed that the sewer would have withstood the pressure. The swimming pool was drained and closed for several days, thoroughly cleaned and again put in use.

The burst sewer was built in 1889 and, like other old storm sewers in Baltimore, was maintained by the city engineer's department. It was a branch of what is known locally as the Harris Creek drain and carried the flow of Ogiers Run. The Linwood Avenue relief drain, of 12¼x12¼-ft. horseshoe section, now nearly completed by the Baltimore Sewerage Commission, will serve this district. For the foregoing information credit is due to Calvin W. Hendrick, Chief Engineer, Baltimore Sewerage Commission.

Erie Flood Investigation

The city of Erie, Penn., has employed the engineering firm Gannett & Seelye, of Harrisburg, Penn., to investigate and report on methods of preventing serious floods in Mill Creek (see report of flood in *Engineering News*, Aug. 12, 1915, p. 326). A force of 24 engineers and surveyors is already at work making a complete topographic survey of the creek and investigating possible reservoir sites and deflection schemes in the upper watershed. At present there is every prospect that the city will go ahead with construction when the proper solution is determined upon.

New Contract for the Automatic Handling of Railway Mail

The Chicago & Alton R.R. has placed a contract for the exchange of mail between trains and stations by the automatic system of the Hupp Automatic Mail Exchange Co. This contract applies to the Chicago and St. Louis line, 284 miles, with 25 mail stations, and the equipment is expected to be ready for service within a few months.

Various automatic systems have been devised and tried at different times, with the purpose of replacing the hand-operated catcher on the mail cars and the practice of throwing mail bags from the cars by hand, but this is believed to be the first case of the use of such a system in regular service on a long stretch of line.

Mechanism on the car automatically opens and closes the door, swings out and returns the catcher, and operates the mail-delivery chute. The mechanism is put into action by a track device, or trip, as the train approaches the exchange point. The bags to be taken are hung to mail cranes in the usual manner, but any number of bags can be taken at each station. The bags delivered fall into a trough alongside the track, thus reducing the liability of damage to the mail. Both ordinary and parcel mail will be handled. An experimental plant was installed on this railway about a year ago.

Seven Hydraulic Elevators Quit

The entire passenger-elevator equipment of the Bowling Green Building, New York City, was shut down because of a pipe breakage, at noon on Sept. 3. The seven elevators were of the hydraulic type manufactured by the Otis Elevator Co., and were installed when the building was erected, about 12 years ago. The accident was caused by the breaking of a supply pipe between the storage tank and an operating valve. No one was injured.

A Wreck in Pinnacle Tunnel, Va., occurred recently, as the result of a broken rail on the outside of an 8-deg. curve, according to F. I. Cabell, Chief Engineer of the Chesapeake & Ohio Ry. The Coal River Ry., on which the tunnel is located, is a branch line of the C. & O., which connects with the main line of the latter at St. Albans, W. Va. The tunnel is 360 ft. long and except for a small portion of its length at each end is lined with timber. The alignment through it is an 8-deg. curve. A train consisting of locomotive, express car, mail-and-baggage car and three coaches was moving eastward when it struck the broken rail 90 ft. from the west portal. The rail was piped through the center of the head in such a way that it could not be detected by ordinary inspection. Fifty feet east of the point of derailment the derailed coaches knocked down 23 lin.ft. of timber lining, which allowed the timber arch and packing above to fall and crush one end of one of the coaches, resulting in serious injury to six persons.

Timber-Preserving Plants in the United States numbered 122 in 1914, according to a report just issued by the Forest Service Bureau of the Department of Agriculture. Of these plants, 100 were of the pressure-cylinder type. The returns received from three-fourths of the plants show a consumption by them last year of over 79,000,000 gal. of creosote oil and of more than 27,000,00 lb. of zinc chloride, besides 2,500,000 gal. of other preservatives, such as coal tar and crude oil. Nearly 160,000,000 cu.ft. of timber was treated, an increase of about 7,000,000 cu.ft. over 1913 and 35,000,000 cu.ft. over 1912. The rapid growth of the industry is also shown by the fact that in 1895 there were only 15 timber-preserving plants in the United States. While the largest use of timber preservation is for railway ties, the room for further growth in the industry is indicated by the fact that as yet only about 30% of the railway ties used are treated with preservative.

The Outstanding Contracts on the extensions to the New York Rapid Transit system on Aug. 1, 1915, amounted in round numbers to $160,000,000, and about 20,000 workmen are engaged. Over 60 sections are now under contract, and the remaining sections, about 20 in number, will probably be put under contract before the end of the year.

Bids for 58 Mi. of Construction Railway, in connection with the Hetch Hetchy water-supply for San Francisco, will be asked within the next two months by M. M. O'Shaughnessy, city engineer of San Francisco. The railway will extend from the Hetch Hetchy dam site to Rosasco. The estimated cost of the work is $1,800,000, and the contractor will be expected to purchase 4½ per cent. municipal bonds to cover the amount of the contract.

The Illinois Structural Engineers Licensing Law has gone into effect, and Governor Dunne on Aug. 18 appointed the Board of Examiners for Licensing Structural Engineers, as

follows: President, E. N. Layfield, 1735 Monadnock Block, Chicago; secretary, James T. Hanley, Chicago; Prof. Ira O. Baker, Urbana, Ill.; John T. Musham, Chicago; C. C. Stowell, Rockford, Ill. The regulations governing the examinations will be made public as soon as they have been formulated.

Traffic Through the Panama Canal—During its first year of operation, ending Aug. 14, 1915, the Canal passed a total of 1317 ocean-going vessels with an aggregate net tonnage, Panama Canal measurement, of 4,596,644, an average of 3490 net tons per vessel. The tolls earned were $5,216,149. In comparison the traffic through the Suez Canal for the calendar year 1914 was 4802 vessels of 19,409,495 net tons. The total receipts were 125,121,237 francs, equivalent at 19.3c. per franc to $24,148,399. There was a considerable falling off in the Suez Canal traffic in 1914 on account of the war. The traffic was, however, about 4½ times as great as that through the Panama Canal.

State-Road Maintenance in Virginia is something of a problem at this time as there has been no appropriation for this purpose for the many miles of state highways in use and under construction. State Highway Commissioner G. P. Coleman is concerned over the situation. He intends to present certain bills to the next general assembly. He recommends:

(1) That the present practice in regard to jail prisoners be corrected. The law contemplates that these prisoners shall be put on the roads, but the present tendency is to keep them in jail where they are of use only in increasing the fees of sergeants and jailors. (2) That the automobile tax be set aside for the upkeep of roads, instead of for new construction.

The Production of Explosives in the United States for 1914, exclusive of exports, according to Albert H. Fay, of the Bureau of Mines, was 450,251,489 lb., as compared with a trifle over 500,000,000 lb. for 1913. This total comprises about 206,000,000 lb. of black powder, 218,000,000 lb. of high explosives other than permissible explosives, and 25,700,000 lb. of permissible explosives. This report is the third issued by the bureau relating to the production and distribution of explosives. In 1902 only 11,300 lb. of permissible explosives was used in coal mining, whereas in the last year 19,593,892 lb. were used. The total amount of explosives used for the production of coal in 1914 was 220,622,487 lb., of which about 8.9% was of the permissible class.

To Reduce Cost of City Telephone Service—With a view to determining whether any reduction in the cost of telephone service in New York City—now amounting to $300,000 annually—can be effected without detriment to the public interest, Mayor Mitchel and Comptroller Prendergast have directed that a comprehensive study of the situation be made. The investigation will be in charge of the following committee: Putnam A. Bates, electrical engineer of the Fire Department and chief engineer of the Bureau of Fire-Alarm Telegraph, chairman; Michael R. Brennan, superintendent of telegraph of the Police Department; Robert J. McIntyre, supervising statistician and examiner, and Chester M. Gould, assistant engineer of the Department of Finance.

A Large Irrigation System in Hawaii, intended to supply fresh mountain water to the Koloa Sugar Co. on the Kauai, is nearly completed, according to an announcement by A. P. Taylor, Honolulu, dated July 30. Over 10,000 ft. of tunnel and several miles of ditches are practically finished. The Waiahole tunnel, 7 mi. long, which extends through the Koolau Range near Honolulu from the windward side of the Island of Oahu to the leeward side, is rapidly approaching completion. This tunnel was projected to carry water from the Waiahole Valley to the land of the sugar company, on the leeward side of the island. The tunnel construction is in charge of Jorgen Jorgensen, a Danish engineer, who has built large irrigation systems on the Island of Hawaii, one of which is known as the Hamakua Ditch.

The Buffalo & Susquehanna Ry., 90 miles long in western New York, was ordered to discontinue its operations by the New York Supreme Court a year ago, as noted in "Engineering News," Nov. 5, 1914, p. 945. The protest of residents along the line of the road to the State Public Service Commission caused the abandonment of the road to be delayed while various plans were canvassed for continuing its operation. It is now announced that the sale of the road will take place under foreclosure proceedings on Sept. 13, and that on that date the property will be purchased by the Western New York & Pennsylvania Traction Co., which operates a system of trolley lines in the region south of Buffalo. The new company will electrify the line and will operate passenger trains by a gasoline-motor locomotive until the electrification is completed.

Recovery of Secondary Metals in 1914, exclusive of iron and steel, was valued at $57,039,706, according to statistics compiled by J. P. Dunlop, United States Geological Survey. Secondary metals are those recovered from scrap metals, sweepings, skimmings, drosses, etc., and are so called to distinguish them from the metals derived directly from ore. The reports of the Survey do not include the large quantity of iron and steel remelted, nor do they include nickel, gold, silver and platinum. The value of the re-used iron and steel amounts to many millions of dollars annually. The recoveries of lead, zinc, copper, tin, antimony and aluminum in 1914 aggregated about 287,000 short tons. As these secondary metals sell at prices only slightly lower than those of new metals and replace an equivalent quantity of primary metals, they must be considered in any estimate of stock available for consumption in any year. Where a special purity of a metal is necessary, primary or virgin pig metal must be employed; but secondary metals are used extensively in foundries, which find this practice necessary in order to compete for business.

The Two Public Service Commissions of New York recently issued a joint order for the first time since the commissions were established. The jurisdiction of the Public Service Commission of the First District is over public utilities within the boundaries of Greater New York; that of the Commission of the Second District is over public utilities in all the rest of the state. The joint order was issued as the result of a joint meeting of the two commissions to consider the removal of grade crossings on the lines of the Harlem and the New York, New Haven & Hartford railways just south of the New York City boundary line. Improvements just north of the city limits were ordered some time ago by the Commission of the Second District. The joint order extends these improvements southward inside of the city limits. The work involves the construction of a viaduct to carry a street over the tracks, the cost of which will be apportioned according to the law, while the cost of the remainder of the work, including a new station for the Harlem company at 241st St., will be borne by the railway companies.

The Railway System of India has its most eastern extension in the new Southern Shan States Ry., lying north of Burma and Siam. This is being built to develop a rich agricultural section and to form a link in the future connection with the railway system of China. The new line opened in 1915 extends eastward from Thazi, on the Burma Railways (306 miles north of Rangoon), to Aunghban, 70 miles, and is to be carried 33 miles further to Yawnghwe. Beyond this surveys have been made as far as Feng Tung, about 270 miles further. At Thazi the elevation is 525 ft. above sea level, rising to 1546 ft. at Lebyin (38 mi.), where commences a 4 per cent. grade 17 miles long, with two switchbacks. The summit elevation is 4603 ft. and then there is a slight fall, Aunghban being at 4214 ft. Steep grades will be required to bring the line down to Yawnghwe at an elevation of 2903 ft. The railway is of meter gage. The sharpest curves are 17 deg., with transition spirals, and the heavy grades (4 and 2½ per cent.) are compensated for curvature. Locomotives of the Mallet type (0:6:6:0) are used on the heavy grades. For about 30 mi. the line is in a very unhealthy district, and a special medical force was organized. Dispensaries and hospitals were established along the work, the construction camps were visited daily, and during the fever season the doctors administered quinine regularly to all the workmen. At some points water had to be piped for several miles or brought long distances by mules. The railway was built for the Government of India by the Burma Railways Co., under the direction of F. D. Couchman, Chief Engineer, and is operated by that company.

ENGINEERING SCHOOLS

Massachusetts Institute of Technology

The contract between Harvard University and the Massachusetts Institute of Technology, under which the Harvard Engineering School was consolidated with the Institute, has been submitted to the Massachusetts Supreme Court in order that the legality of the contract may be authoritatively determined by that body. As will be remembered, an important feature of this contract is that Harvard turns over to the Institute three-fifths of the income from the Gordon McKay endowment. The trustees of the endowment, however, have filed with the court a protest alleging that under the terms of Gordon McKay's will this transfer to the Institute which Harvard Univer-

sity has agreed to make will be illegal and void. Under the terms of McKay's will, the income from the fund that he bequeathed to Harvard University will greatly increase in future years. The trustees under the will have already paid over to the University about $2,000,000, and more than $5,500,000 additional is now in the trustees' hands. The final amount of the endowment, after life interests established under the will have ceased, will exceed $22,000,000, even if all the income from the endowment is spent by the University and none is reserved for accumulation. The amount at stake therefore is very large.

The principal ground on which the trustees attack the transfer as illegal is that it is contrary to the intentions of the testator. The trustees declare that Gordon McKay during his lifetime was entirely familiar with the work of the Institute of Technology and was repeatedly solicited by persons connected with it to intrust to the Institute the management of the educational endowment he proposed to create. He, however, deliberately and intentionally selected Harvard University instead.

It is further stated that Mr. McKay was on terms of close intimacy and friendship with the late Prof. N. S. Shaler during the years from 1891 to 1906, when the latter was the head of the Lawrence Scientific School, and it was largely through Shaler's influence that McKay finally determined to make Harvard the beneficiary under his will. The trustees further declare that it was McKay's intention to have his benefaction used in promoting a wide range of scientific subjects and not be restricted to engineering and its applications, and that the Harvard University authorities cannot legally relinquish their jurisdiction over a definite proportion of this fund to the authorities of another institution.

Colorado School of Mines

The Joseph A. Holmes Chair of Safety and Efficiency Engineering has been established in this school as a memorial to the late Dr. Joseph A. Holmes, Director of the United States Bureau of Mines.

PERSONALS

Mr. O. H. Lang has been appointed Engineer of Highways of Thomas County, Georgia, with headquarters at Thomasville.

Mr. William B. Bamdford, M. Am. Soc. C. E., Architect and Consulting Engineer, of Belmar, N. J., has been elected a member of the City Council of Belmar.

Mr. N. Everett Waddell, Assoc. M. Am. Soc. C. E., will hereafter be associated with his father, Mr. J. A. L. Waddell, M. Am. Soc C. E., in partnership under the firm name of Waddell & Son, Consulting Engineers, 800 Graphic Arts Building, Kansas City, Mo.

Mr. R. T. Childs has resigned as Editor of the construction news department of "Engineering News," to take charge of an important real-estate development at Mineola, Long Island. His New York office address is 358 Fifth Ave., Shawmut Realty Co. He is a civil-engineering graduate of Rensselaer Polytechnic Institute, class of 1903, and was formerly a member of the editorial staff of "Iron Age." He has been with "Engineering News" since December, 1909, and he originally established the department of market prices of engineering materials, appearing in the first issue of each month. Mr. L. V. Fletcher, as head of the business news department of the Hill Publishing Co., has assumed Mr. Childs' work. He has been with the F. W. Dodge Co. construction report agency for 10 years, for five years being in charge of the news-gathering service of the eastern office.

OBITUARY

Samuel Todd Davis, Jr., President of the Locomobile Co., of Bridgeport, Conn., died at Fairfield, Conn., on Sept. 1, in his 43rd year.

William John Noonan, for 20 years a member of the Ottawa River Works Department, and later engineer for the City of Ottawa, Ont., died recently at his home in that city from pneumonia.

Thomas W. Burrows, formerly General Superintendent of the old Chicago & Erie R.R., died at his home in Lima, Ohio, on Aug. 30, at 63 years of age. He was engaged in railway work most of his lifetime.

Alexander Wilson, formerly Superintendent of the Railroad Department of the Cambria Steel Co., died at Johnstown, Penn., on Aug. 30. He had served as Mayor and Comptroller of Johnstown. He was 75 years old.

E. F. McCrea, Division Engineer of the Cleveland & Pittsburgh division of the Pennsylvania Lines, died on Aug. 28 at his father's home near Logansport, Ind. Mr. McCrea had been in the Pennsylvania's service since 1899.

James W. Cain, formerly Superintendent of Highways of the Borough of Queens, Long Island, died at his home in Bayside, L. I., on Aug. 27, at 70 years of age. Mr. Cain was a resident of Bayside nearly all of his life and was widely known in political circles in Queens.

Griffith W. Lewis, State Director of Railroads of New Jersey, died suddenly from heart trouble at his home in Burlington, N. J., on Aug. 28, at 51 years of age. He served in the State Senate in 1910 and for many years was identified with Republican affairs in Burlington County.

I. N. Robinson, Road Overseer of Ouray County, Colorado, was instantly killed in an automobile accident on Aug. 24. He was on his way to Portland to inspect a bridge which was being constructed there across the Uncompahgre River. His son, who accompanied him, was seriously injured.

J. W. Harry James, a civil and mechanical engineer, of the American Bridge Co., of Wilmington, Del., died at his home in Chester, Penn., on Aug. 28. He was born in England, and prior to his residence in this country had charge of various engineering works in England, France and Russia. He was at one time Consulting Engineer of the Department of Public Works of India.

John R. Graham, President of the Bangor (Me.) Railway & Electric Co., died on Aug. 24 at Intervale, N. H., while on vacation. For many years Mr. Graham was a resident of Quincy, Mass., until about 10 years ago, when he moved to Bangor, and was well known in railway affairs in both cities. At one time he was President of the old Boston & Quincy Railway Co. He was 68 years of age and 10 children survive him.

Gen. John H. Albin, of New Hampshire, President of the Connecticut River R.R., died recently. He was a graduate of Dartmouth College and practiced law in the State of New Hampshire the greater part of his lifetime. For many years General Albin was a Director and President of the Sullivan County R.R., in the Connecticut Valley, and was also a Director of the Vermont Valley R.R., and a Director and President of the Concord Street Ry. He was a Director of the Connecticut River R.R. and in 1914 was elected President, to succeed the late Lucius Tuttle.

John Haines Warder, Assoc. Am. Soc. C. E., Secretary of the Western Society of Engineers, died at his home in Chicago on Aug. 30, at 70 years of age. Mr. Warder was a graduate in mechanical engineering of the Polytechnic College of Philadelphia, and was engaged in engineering work the most of his lifetime. At one time he was connected with the Cincinnati Southern Railway System and was engaged in bridge inspection at various times at the Phœnix Iron Works and in the cites of Detroit, Pittsburgh, Edgemoore, Minn., Athens, Penn., Elmira, Rochester and Chicago. He also had much to do with planning the power and electric plants of Chicago. At the time of his death he was Assistant Engineer of the Bureau of Sewers of that city. He had been Secretary of the Western Society since January, 1901.

William L. Ziegler, Engineer of Construction of the Pennsylvania R.R., died Aug. 6. He was born in Harrisburg, Penn., Aug. 15, 1847, and graduated from the Central High School, Philadelphia, in 1865. He joined the engineering corps of the

Pennsylvania R.R. two years later as a chainman. Having served as rodman, levelman and transitman, he was promoted to be Assistant Engineer in 1873. In 1875 he was appointed Assistant Engineer of Maintenance-of-Way, in charge of the construction of the tracks and station in Fairmount Park to take care of the Centennial traffic in 1876. Afterward he became Engineer of Construction in charge of the union station and carsheds at Pittsburgh. In recent years he had charge of the construction of some of the most important improvements made by the railway company in Philadelphia.

J. G. Metcalfe, formerly President of the Mexican International Ry., and recently consulting railway expert for Speyer & Co., bankers, of New York City, died at Pocono Summit, Penn., on Aug. 31, in his 67th year. Mr. Metcalfe was born in Cambridge, Ohio, and started his railway career as a telegraph operator. In 1900 he was made General Manager of the Denver & Rio Grande R.R., and later held the same position on the Evansville & Terre Haute R.R. In 1902 he was appointed President of the Mexico International Ry., and for a year, starting in 1904, was Vice-President of the National Lines of Mexico. In 1905 he became Vice-President of the Manila Railway Co., and retained that position until his death, at which time he was also Vice-President of the Bolivia Railway Co. and a Director of the Missouri Pacific R.R. He took an active part in solving transportation problems in South America, and some years ago was called to London to give expert advice on the London Underground Railway Co.'s problems.

ENGINEERING SOCIETIES

COMING MEETINGS

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 7-9. Convention in New York City. Secy., Willard Kent, Narragansett Pier, R. I.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual meeting in Chicago. Secy., W. O. Thompson, N. Y. C. R.R., East Buffalo, N. Y.

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Oct. 11-12. Secy., Will P. Blair, Engineers Bldg., Cleveland, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

SAN FRANCISCO MEETINGS

INSTITUTE OF RADIO ENGINEERS.
Sept. 13-18. Secy., David Sarnoff, 71 Broadway, New York.

PAN-AMERICAN ROAD CONGRESS.
Sept. 13-18. Secy., E. L. Powers, Road Builders Association, 150 Nassau St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Secy., Bradley Stoughton, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Secy., J. J. Blackmore, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Sept. 17-21,

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20. Secy., Arthur Hooker, Sacramento, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. 20. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. 20 and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell, Secy., Comm. of Management, Foxcroft Bldg., San Francisco.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30. A. C. Carruthers, Vice-Pres., Collective Insurance & Universal Safety Exhibit, Mines and Metallurgy Bldg., San Francisco.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

County Highway Engineers' Association—The ninth annual session will be held at Hannibal, Mo., Sept. 13-15. The secretary is E. W. Sheets.

Pennsylvania Welfare and Efficiency Congress—The third annual conference will be held in Harrisburg, Penn., Nov. 16 to 18, and the annual exhibit Nov. 15 to 19.

Engineers Club of St. Louis—A reunion meeting was held at the club on Sept. 8, at which several of the members gave their impressions of the Panama-Pacific Exposition.

American Institute of Consulting Engineers—The Institute has recently joined the Chamber of Commerce of the United States and claims that it is the only engineering organization which has membership in that body.

Youngstown Engineers' Society—The Youngstown (Ohio) engineers will hold a picnic at Milton Dam on Saturday, Sept. 11. The trip to the dam will be made in automobiles. The Milton reservoir is situated 17 mi. west of Youngstown. Its capacity is 10 billion gallons, length 6 mi., greatest width 1½ mi., depth of water at spillway 46 ft. The earth-fill dam contains 200,000 cu.yd. The secretary is L. P. Fawcett.

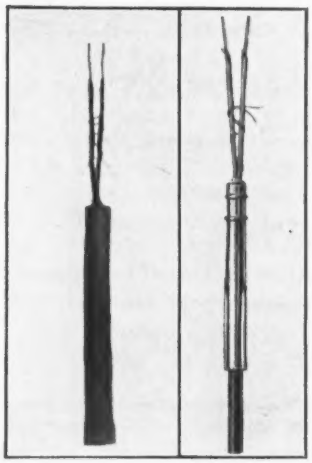
Canadian Engineers representing the British Columbia and Alberta members of the British Institution of Civil Engineers, the Canadian Society of Civil Engineers and the American Society of Civil Engineers have made arrangements with the Southern Pacific and the Canadian Pacific Ry. companies for special train and steamer facilities from San Francisco via Victoria and Vancouver and Calgary to Chicago in order that the members of the International Engineering Congress may have an opportunity to view the Canadian Rockies and to visit some of the engineering works along this route. C. W. Allen, engineer of the Dominion Water-Power Branch, in charge of the water-power exhibit in the Canadian pavilon at the Panama-Pacific International Exposition, has arranged to make the final preparations for the trip, and requests for information should be addressed to him.

National Conference on Concrete Roadbuilding—The second national conference will be held in Chicago, Sept. 15 to 18, at the Auditorium Hotel. The following subcommittees will report: Drainage and Preparation of Subgrade, Hector J. Hughes; Economical Widths of Pavement and Shoulders, J. J. Cox; Problems of Design, Thickness, Crown and Grade, Ira O. Baker; Aggregates, D. A. Abrams; Handling and Hauling Materials and Water-Supply, T. R. Agg; Organization of Concreting Crew, H. P. Gillette; Proportions of Materials and Consistency of Concrete, W. S. Gearhart; Mixing and Placing Concrete, Ernest McCullough; Reinforcement, Richard L. Humphrey; Joint Location and Construction, George A. Ricker; Expansion and Contraction, F. E. Turneaure; Finishing and Curbing, Charles Whiting Baker; Construction of Shoulders and Curbs, A. N. Johnson; Methods and Cost of Maintenance, A. H. Hinkle. Form of Specifications, A. R. Hirst; Cost of Construction, C. J. Benett; Estimating and Inspection Problems, A. Marston. The office of the secretary is at 208 South La Salle St., Chicago.

Appliances and Materials

Delay Electric Detonators

Two detonators for use in tunnel driving, shaft sinking, etc., which will set off the various charges of explosives as desired by one operation of a blasting machine or one application of electric current, are now manufactured by the E. I. du Pont de Nemours Powder Co. One is called the "du Pont Delay Electric Blasting Cap" and the other the "Delay Electric Igniter." They differ in construction, but have the same purpose. The caps are made with two delays, and are similar in outward appearance to the ordinary electric blasting caps, except that the copper shells are slightly longer and are covered with a rubber tube. The delay is accomplished by the use of a slow-burning material inside the shell, which is ignited by the electric current passing through the bridge wires. When this material has burned to the fulminate charge in the shell, the latter explodes and in turn detonates the explosive. In use the instantaneous electric blasting caps are placed in the hole or set of holes which should be detonated first and simultaneously; the first delays are placed in the hole which should be detonated second; the second delays are placed in the holes to be detonated third. Ordinary electric blasting caps can be used in dry work, but in wet work the waterproof electric blasting caps should be used in connection with the delay electric blasting caps, the latter being made on the waterproof type.



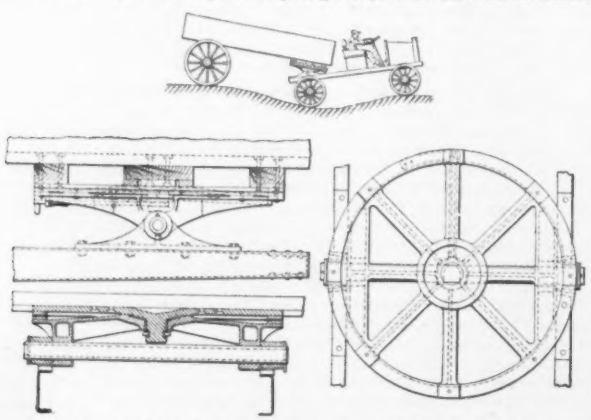
DELAY ELECTRIC BLASTING CAP AND DELAY ELECTRIC IGNITER

The delay electric igniter is made with a number of delays. It consists of a small brass tube, into one end of which the igniting material, composition plugs and wires, are inserted and fastened. These extend about half the length of the tube. Into the other end is inserted a piece of fuse, which touches the igniting material and which is clinched securely in the brass tube. The delay is brought about by using different lengths of fuse, the first delay having 2 in. of fuse, the second 4 in., etc., the fuse length increasing 2 in. for each delay. The wire lengths are the same as for the regular electric blasting caps.

* * *

Flexible Fifth-Wheel for Tractor-Trailer

A fifth-wheel attachment with unusual features, an appliance designed to convert any motor truck into a tractor for handling a two-wheel trailer, has been put on the market by C. H. Martin, 293 Bridge St., Springfield, Mass. This fifth-wheel connection, as the accompanying sketch shows, has a crosswise hinge which gives longitudinal flexibility, thus permitting the vehicle as a whole to conform to the unevenness of the road. No longitudinal hinge is provided, for the reason, it is claimed, that this would permit sidewise tipping of the load on curves or on a crowned road, and thus interfere with the stability of the vehicle. The Martin patent fifth-wheel is made of steel in several sizes from an 18-in. circle for Ford cars or light runabouts ($25) to a 36-in. circle for 5-ton trucks ($90). The top member may be bolted to the cross-bolsters of any wagon and the lower member to the frame of any truck.



MARTIN PATENT FIFTH-WHEEL FOR TRACTOR-TRAILER CONNECTION

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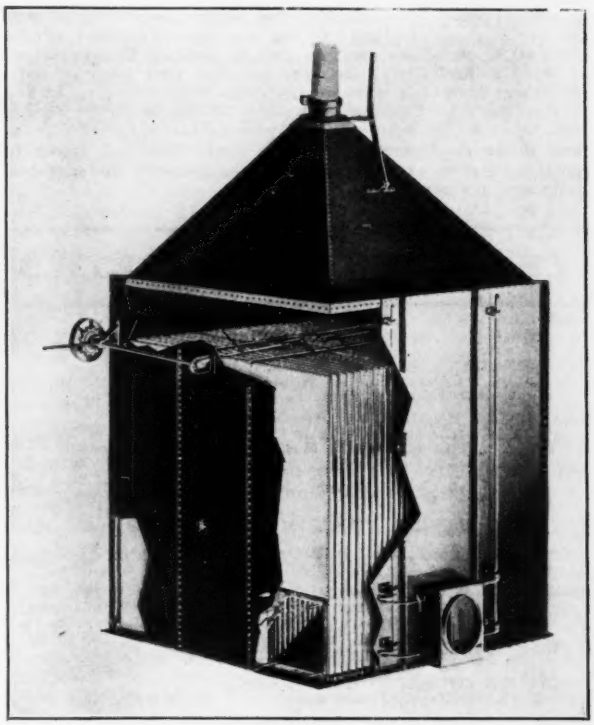
Cloth-Screen Dust Arrester

A device for collecting dust from tumbling mills, emery wheels, sand-blast equipment, etc., was recently placed on the market by the Whiting Foundry Equipment Co., Harvey, Ill.



CLOTH-SCREEN DUST ARRESTER

The makeup of the arrester is shown in the accompanying view. It consists of an outside case or house of heavy sheet steel in which is located a series of cloth screens that permit free air passage. Air which has passed through this arrester is claimed to be entirely satisfactory to breathe.

* * *

Automatic Gas Street Lamps

An automatic gas lighter has been devised by the Automatic Gas Lighting Equipment Co., of Boston, Mass. This is intended to take the place of the men and boys who are universally employed for lighting and extinguishing gas street lamps. A clock box is attached to the Welsbach lamp standard and the clock mechanism in it operates a tripping lever controlling a double-acting valve. When the gas supply is open the pilot supply is closed, and vice versa. The pilot comes up through a small hole in the center of the gas cap and the flame may be adjusted to use 0.1 or 0.2 cu.ft. per hr. The lighting and extinguishing times are regulated by a control dial inside the clock box.

This device has been used in Newton, Fall River, Gardner and Quincy, Mass., and other cities in from 100 to 1000 units. It is claimed that one man can easily look after 250 to 300 of these machines and lamps, doing all the inspection, cleaning, winding, replacing of mantles, etc. It is claimed that the cost of running a lamp so equipped, including labor, mantles, chimneys, globes, domes, clock repairs, depreciation and interest at 10 per cent., totals about $6 per annum, which is to be added to the local cost of gas, which may vary from $9 to $12. The cost of street lighting where hand extinguishment and lighting is employed is in the vicinity of from $24 to $30 per annum.